UNIVERSITY OF ALBERTA

TOWARDS ECOSCIENCE: ENVIRONMENTAL AND SOCIOCULTURAL PERSPECTIVES IN SCIENCE - SOME INSIGHTS FROM UGANDA, AND IMPLICATIONS FOR HIGHER EDUCATION

BY

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled *Towards Ecoscience: Environmental and Sociocultural Perspectives in Science - Some Insights From Uganda, and Implications for Higher Education* submitted by Silas Omoding Oluka in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Science/Environmental Education.

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DEDICATION

To the Elders in my life, luka' *Toto*, luka' *Tata*, luka'*Papa*, who, in the darkness, have illuminated the paths of my sojourn...
and taught that the child in me is the father I will be...

ABSTRACT

Among the poor nations in the South, claims and beliefs in science and technology center in their potential to enhance economic growth through exploitation of ecological systems to as in the industrialized nations. Expectations are that science and technology will continue to contribute to an improving quality of life for all people. For Uganda, great emphasis is placed on the teaching of science and technology as a means of strengthening the scientific and technological capacity particularly at higher institutions of learning like Makerere University. This advocacy has been translated into increased admission of students, with special incentives for women participation, to bolster scientific and technological literacy in the country. In spite of these efforts, there is worsening poverty and growing environmental problems of deforestation, soil erosion and deteriorating soil quality, waste disposal and sanitation, pollution, shortage of cheap and affordable energy, and lack of clean water. A common interpretation of this worsening social and ecological crises is accrued to lack of modern science and technology and to poor production levels for international markets. These contradictions and malaise invite a critical analysis of the foundations and assumptions inherent in the contradictions between the dominant notions of development, use of science and technology, social alienation and the ecocrisis.

This inquiry thus probed into perceptions about science and its applications towards social change and how these are placed in a broader perspective to capture sociocultural and ecological sustainability. Makerere University and an indigenous rural community of Osukuru were used as the setting for the study as they are the acclaimed targets of Ugandan development policies and programs which seek to move the country out of primitivity and backwardness and into a modernized society. A qualitative methodology involving focus group discussions, interviews and a workshop was employed in exploring perceptions, beliefs, assumptions and insights about science and its role in development and environmental conservation, of indigenous perspectives of development, and ecological well-being, and how these are shaped by various worldviews. With little known about how indigenous knowledge and worldviews could work in concert with modern science and technology in the African setting, the study initiated dialogue among scientists government officials, and rural elders towards appropriate harmonization of modern science and technology with local needs and knowledge ways in that promise ecological sustainability and cultural balance.

The data indicated that science in Uganda is predominantly regarded as an exploration of natural phenomena and as a body of facts to be memorized or discovered by students within the defined process skills of scientific inquiry, irrespective of context. The nature of the market economy, its application of science and subsequent impacts on society and the environment were not seen as the responsibility of scientists, science research, or discourse. Rather, they were seen as "problems" for the politicians, industrialists and international or corporate organizations. There were no indications of planning, teaching nor research in science and technology education that explored the linkages and issues related to the interactions of economy, society, environmental degradation and the role of education, or related policy implications for science and technology education. The science curricula at the university and school setting are predominantly academic, descriptive, knowledge-based as in grammar-school traditions in the industrialized nations. Apparent was the delegitimation of indigenous knowledge and values in science and science education, enhanced by an academic ethic which seeks identification with educational institutions and peers in the North than with the rural masses. Ties between the local elite and their counterparts in the North also impact on representativeness and responsiveness of policies to majority needs and environmental care. To illuminate the ways in which science and technology at the university and school system should be culturally informed, the study recommends a framework of science and science education which could foster closer alliances with indigenous knowledge, the needs of the majorities, including women, and sensitivity to ecological balance. Such a socially and ecologically responsive science could play a crucial role of combating social injustice, and develop critical scientific and political awareness essential for the redirection of the scientific and technological discourse along more socially just and ecologically sustainable lines.

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List of Acronyms

CASTAFRICA	Conference of Ministers of African Member States Responsible for Application of Science and Technology to Development
CIDA	Canadian International Development Agency
IDRC	International Development Research Center
IMF	International Monetary Fund
IPCC	Intergovernmental Panel for Climate Change
IUCN	International Union for Conservation of Natural Resources
LC	Local (Village) Council
NARO	National Agricultural Research Organization
NCDC	Uganda National Curriculum Development Center
NGOs	Non-government Organization
NUFU	Norwegian National Committee for Development Research and Education
OAU	Organization of African Unity
STS	Science Technology and Society
UACE	Uganda Advanced Certificate of Education
UCE	Uganda Certificate of Education
UCE	Uganda Certificate of Education
UNEB	Uganda National Examinations Board
UNEP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
UV rays	Ultra-Violet rays/radiation
WCED	World Commission on Environment and Development
WWF	World Wildlife Fund

CHAPTER ONE

INTRODUCTION

1.0 Background

Uganda is a landlocked nation with an area of 241,500 square kilometers located in the equatorial belt of what is now East Africa (see Appendices A1, A2). Uganda is also a multicultural and multi-religious society with a population estimated in 1994 at 17 million with a growth rate of 2.5 per cent per annum (Okoth, 1995). According to the 1991 national census, approximately 90 per cent of Uganda's population is rural. The same statistics give the proportion of female population as 51 per cent of the total. Since Uganda became a British colony in the mid 1890s, the concept of nation building and national development became central as organizational frameworks for the people and successive governments.

In spite of its political independence since 1962, Uganda's strong ties with former colonizers have drawn Uganda into the global market economy, its role being the production of cash crops such as coffee, cotton, tea, tobacco, and some minerals for export. As a result of the socio-economic stagnation and social security disruption during the decade of 1970s under Idi Amin, Uganda's processing and manufacturing industries have remained relatively underdeveloped. Since 1986 under the new governance of the National Resistance Movement (NRM) government, there has been a concerted promotion of and resultant accelerated growth in industries and agricultural production. These efforts have contributed to the record annual growth rate of 6 per cent in the economy of Uganda over the last few years (New Vision, 1996). These phases of rapid population growth, and the current "improvement" of the Ugandan economy, can be linked to the agricultural and industrial revolution which began in Western Europe in the eighteenth century.

It is no coincidence that the emergence of these patterns of production and consumption coincided with the global expansion of the Western European states in an attempt to extend their political and commercial control. The conquest and colonization of most nations in Africa and elsewhere in the world by Europe is seen by most analysts as a means to access the raw materials and cheap labor from the colonies acquired (White and Whitney, 1992). The extraction and conversion of raw materials to various goods for distribution in markets has, over the last century, increasingly depended on the use of modern science and technology. In the post-colonial epoch, the role of modern science and technology imported from the industrialized world into developing nations has continued to gain stronger influence locally due to a general and widespread faith in science and its technological applications as powerful agents for economic and social progress (Leiss, 1990; Griffin, 1989). Accordingly, educational institutions like universities are charged with the responsibility of fostering an instrumental use of scientific knowledge in pursuit of accumulating natural resources' productive capacity (Constitution of Republic of Uganda, 1995; White Paper on Education Review in Uganda, 1992). The social and political malaise of the industrialized nations, however, indicates that scientific and technological development are not necessarily automatic guarantees of well-being for all. The ecological degradation and social alienation of the late twentieth century exposes the destructive impacts of misapplications of science and technology when wealth creation and material accumulation take priority (Caldicott, 1990; 1995; Orr, 1994; Suzuki, 1994). To many critical minds today, there is a growing interest in seeking to clarify the dialectical relationships underlying the accelerating ecocrisis, the social dynamics which sustain modern scientific and technological progress, and material and/ or wealth accumulation. Because the goals of developing countries are pegged to raising living standards and feeding growing populations as well as competing economically, to some extent, with the industrialized nations, science and technology will remain important agents of socio-political change (Griffin, 1989; Suzuki, 1994). Besides the threatening ecological crisis many societies face as a result of modernization, the widening poverty and scientific-technological gaps between and within nations raise serious challenges to the role of education in South nations like Uganda. The forthcoming chapters of this study will reflect on how science and technology have operated in a dialectic of increasing mastery over ecosystems and people with particular reference to Uganda.

1.1 Makerere University Science Program in National Development

The Faculty of Science at Makerere University was first established in the 1940s with the dual mandate to offer undergraduate training in the biological sciences and conduct research in these fields. Over the years, other science disciplines such as Botany, Zoology, Biochemistry, Physics, Geology, Statistics, Mathematics and Chemistry were introduced into the Faculty. Postgraduate training in most of these subjects has been going on for several decades, including the Institute of Environment and Natural Resources which currently concentrates its programs at the graduate level. Admission requirements to undergraduate courses are two advanced level certificate principle passes or a special mature age entrance exam and satisfactory performance as established by the committee concerned at the university. The three-year undergraduate training involves considerable practical work in the laboratory in all subjects with perhaps the exception of Mathematics.

In Biology, Chemistry, and Geology units some field work is also involved. Graduates from the Faculty are employed in processing industries; Physics graduates gain employment in the fields of telecommunications and engineering. Botany and Zoology graduates are engaged by animal and/ or plant research centers across the country; and, other science graduates, with or without professional educational training, are often employed as science teachers in high schools. The Faculty of Education, which has a department for science and technology education, is the hub of education in Uganda since the university's inception as a college in 1922. It the oldest faculty in the university. Undergraduate science education students take courses concurrently in the Faculty of Science and the Faculty of Education. The courses include educational foundations, curriculum, science education methods, and educational psychology during their three year Bachelor of Science with Education program. The undergraduate education students are required to take a three-month school practicum in their second and final year of the program, while the postgraduate diploma candidates have a single, six-month practicum. Holders of a Bachelor of Science degree can register for a nine month postgraduate diploma program to qualify as science teachers.

The university science and science education programs are mainly fed from the lower structure of formal education which consists of seven years of primary education with a curriculum consisting of Science, Mathematics, English Language and Social Studies. This is followed by a four-year school certificate program called "Ordinary" (O) level, and two years of "Advanced" (A) level certificate as a pre-university stage of education. Both the "O" and "A" levels have science disciplinary structures tailored to the university structure of science programs. Students who do not make it to university have entrance opportunities into other tertiary institutions which offer various professional diploma programs in the fields of agriculture, forestry, paramedical practice, fisheries, education, technical and business vocations.

Makerere's colonial ties to universities in Britain have strongly influenced the organization of its Science Faculty and the way in which science is taught in the university as well as in other educational levels in Uganda. The Faculty comprises the "traditional" disciplines, namely: Physics, Biology or Biological Sciences, Chemistry, Geology and Biochemistry (see Appendix C). The continuous pursuit of curricula modeled after the industrialized countries can lead, however, to the hegemony of North industrialized countries of knowledge in societies like Uganda (Apple, 1996). Furthermore, a positivist orientation to science has tended to pay little attention to local social and environmental issues of local populations. In recognition of the diversity and multiple interpretations of reality, analysts like Hodson (1993) criticize the dominant modernist view of science and technology in education, calling for an open multicultural and contextually meaningful science and its applications.

Lately, educational reforms in Uganda strongly advocate for the development of science and technology curricula which will facilitate Uganda's entry into the rapidly changing scientific and technological world. As the government White Paper on Education (1992) strongly recommended, Uganda's educational system should "promote scientific, technical and cultural knowledge, skills and attitudes needed to promote development" (p. 8) and " the creation of national wealth" (p. 6). While the White Paper recommends environmental care, there is an overwhelming emphasis placed on the exploitation of the environmental resources as a means to satisfy social and economic needs.

Educational policy makers including curriculum developers in science and technology are among those in the forefront in framing the role of science and technology in national development, and in shaping the schooling agenda to respond accordingly. Since independence, various governments in the South have committed large sums of money towards educational expansion -- especially in public and post-secondary science and technology education -- on the assumption that such an investment will automatically lead to development. Interest in these issues inspired this inquiry as an effort to initiate an interrogation of dominantly held views about education and knowledge production involving science and technology, and their role in development in Uganda. The central concern was to observe, understand, and in all ways possible seek frameworks which could inform and guide ways of how universities teach science which is appropriate to sustainability, as well as to socially and ecologically sound, meaningful development. In development education, environment is increasingly becoming an area of great concern given its centrality to overall quality of life. The implications these concerns have in rethinking frameworks of development[1] cast equal challenges towards revisioning the role of science and its applications that have the attributes of appropriateness, social and ecological soundness, and are compatible with sustainability. Education as a means by which attitudes to life are shaped means that its transformative capacities -- in search for change -- should foster critical awareness which can inform and guide social and environmental consciousness (Freire, 1970; 1995; Apple, 1996). In the Freirean perspective, education should recognize the partial, contingent, and uncertain character of all knowledge and the heterogeneity of social, cultural, and institutional life (Freire, 1970). Such an education should thus seek to transform knowledge for the interests and cultural foundations of the powerless, who constitute a large proportion of the population in South nations like Uganda.

---

[1] *"Development" is used here to mean the multi-dimensional process through which a given society moves towards the achievement of mutually held goal of happiness, freedom and self-actualization as a people. This definition of development is unique because it places minimum requirements of physical and human resources as well as economic, social, political mechanisms for its attainment. Some management structure to coordinate resources, production and distribution of benefits among members of the society is also implied.*

From a pedagogical perspective, my experiences about ways in which physics and other science subjects are taught abound with observations of textbook knowledge, use of the scientific method, and the performance of highly structured and rigidly controlled experiments. My student days are full of the "cut-and-dry" approaches and perspective of science. Such a privileging of experience over theory has influenced me and others socialized in empirical scientific discourse to uncritically celebrate empirical realism, impartial and disinterested knowledge, and the refusal to recognize that all forms of analysis are simultaneously forms of advocacy having their own relevance (Feyerabend, 1991). As Agger (1989) has equally argued, a denial of other forms of analysis has fostered the development of an epistemology in which there exists a stress on validity and measurement, an analytic cleavage of description and exhortation, a separation of knowledge and desire, the sundering of analysis and social reality, and the refusal of teachers to narrate their own ideological contingency within networks of power relations.

Ezeife (1994) in his review of physics teaching methodology in Nigerian high schools acknowledges the dominance of traditional, text-book-oriented, and teacher-centered approaches. He also alludes to the preaching of an anti-science propaganda to students by non-science teachers. In particular, he notes that girls are being dissuaded from studying science subjects because "it is not a suitable career for them" and "girls who do physics are (perceived as) crazy and unsociable" (p. 15). Ezeife's exposition reinforces some of my own personal experiences both as a learner and teacher, and raises important questions about public perceptions of science and the science curriculum and of the role which science should play in society. Brouwer (1989; 1993), in his analysis of a public image of a physicist, expresses fear that as result of people's interest to gain knowledge about and exploit nature, difficult choices will increasingly be faced by scientists in a world in which the social implications of scientific discoveries and consequences of science-based technology, are immense, if not overwhelming.

Central to the concerns of this study is the public perception that scientists are always open and receptive to new ideas and social participation based on "rational" and "objective" assessment. Ezeife's observation, however, should lead us to query this perception since scientists and science educators may express biases which are territorial, dogmatic, and tunnel-visioned. It raises larger questions about the opportunities for women and other marginalized groups to participate in generation and utilization of scientific knowledge in a world which is becoming more concerned with social and cultural equity. Similarly, Brouwer's (1988) analysis of challenges facing science draw attention to discuss science and in the contexts of social responsibility as well as that of the escalating ecocrisis.

1.2 Science, Technology, the Ecocrisis and the Role of Education

To writers like Leiss (1990), scientific and technological societies have evolved a behavioral orientation characteristic of mass-consumption societies which view the natural environment solely as a means for supplying societies' wants. These insights draw the attention of educators and national leaders to the concerns of traditional societies who constitute the majority in the South. Historically, traditional societies have viewed their natural surroundings as a source of sustenance. However, over and above their awareness of nature's ability to supply their material wants, indigenous peoples have also accorded symbolic meaning and spiritual significance to nature's biodiversity and physical features. According to Suzuki (1990), these societies also valued a sense of community. The globalization of trade in which countries are increasingly forced to integrate into the world economy based on open competition has been seen by some analysts like George (1976) as undercutting community values such as social justice, equal opportunity, sustainability, and ecological balance. George and other scholars like Suzuki (1994) note a shift in focus to short-term returns and maximization of profit promised by modern science and technology. In the Canadian Prairies for example, there is wide-ranging evidence of the disappearance of small-scale farmers due to the pressures of cost-intensive high technologies and large-scale farming imposed by global market forces.

In many places in the world, farmers who grow the very foodstuffs that keep people alive can barely make a living, even when there are bumper harvests, while brokers, who make no contribution to the improvement of the planet, make millions of dollars in the stock markets from farm proceeds. In the developing nations, the picture is even more grim. As Nietschmann (1987) has observed, one of the most disturbing consequences of the development vision among developing nations is the numerous so-called liberative campaigns (more often coercive) waged by governments against their own peoples. Many countries in the South, including Uganda, are now experiencing environmental degradation due to the problems of industrial pollution and inadequate waste disposal for which neither government nor the masses are equipped to address. Environmental degradation has become almost as serious a threat as war because it is a crucial security issue to humanity.

In the midst of these real conflicts, conceptual debates and "wars" over the environment and development are being fought on the academic battleground, with educational institutions increasingly serving as centers for socializing the youth on forms of knowledge and skills for resource exploitation and economic progress (Leiss, 1990). Leiss's analysis also links this ideology and trend to the industrial revolution where the impact of accelerating scientific discovery and its successful technological application led to an emphasis on the unity of theoretical and practical knowledge for economic growth. This economic growth exists to the extent that life in the world is increasingly constructed on the foundations of "limitless" material accumulation based on modern science and technology.

Authors like Meadows et al. (1992) express fears that national pursuits of economic growth are being pushed to such limits that the immense damage to the fabric of human life and balance of other ecosystems could be irreversible. Other analysts like Bailey (1993) take a skeptical stance and view the emerging environmentalist movement as extremist thinking, arguing that the limits to growth are still far off and that both humanity and natural ecosystems are sufficiently adaptable. Such debates not withstanding, proponents like US. Vice President Al Gore (1992) who argues for sustainable futures based on a healthy planet, cautions that environmental problems may never put the earth in balance and that some changes could have a heavy toll in the foreseeable future. As Kaplan (1994) notes, it is high time to acknowledge that the environment is a national developmental and security issue of the twenty-first century. Environmental changes which threaten peace and security at the regional level are deeply rooted in economic and physical resources or features, often leading to fights to gain control (MacNeill et al., 1991).

In seeking to attain and maintain a modernization model of development, it is apparent that many assumptions have been made by governments -- particularly among poor nations -- regarding social and environmental policies. From the perspective of developing nations characterized by their poverty and now referred to as the *South*, development strategies based on the experiences and interests of the rich industrialized countries (called the *North*), or those based on Marxist theories are inadequate. Both strategies proved incapable of using existing resources to generate a better quality of life consistent with sustainability and equity for the poor without taking an irreversible toll on the environment (Pepper, 1986; Toh and Cawagas, 1989). It is the poor majority in developing countries who are the perpetual losers and the most affected by the process of environmental depredation whether, as Redclift (1984) has noted, the process has been initiated by large-scale capital or the poor themselves acting as the agents of resource depletion. The notion of "sustainability", critically defined, captures the logic of environmental use and care, and the extent to which this resource base can possibly continue to guarantee existential needs of humanity (Norgaard, 1994).

As Franklin (1990) cautions, science and technology are more than mere concepts and artifacts; they involve practice and strongly influence social organization. Viewed from this perspective, science and technology becomes a form of culture[2] the orientation of which affects the ingredients that define the quality of life. Technological development is a complex process requiring the critical understanding of not only specialists but also educators in their role as nation-builders. It is clear now, more than before, that technological development cannot take place in isolation. Technological development is much more than the overt acceptance of material and technical improvements; it is an ecological, cultural, social and psychological process as well (Leiss, 1990). Every technical change has an environmental impact; there are also corresponding changes in the attitudes, thoughts, values, beliefs and behavior of the people who are affected by the material change (Norgaard, 1994). Unfortunately these changes are often overlooked or their significance is underestimated because they are more subtle, or simply taken to be a normal consequence of technology which can be fixed with another form of technology. Even when the ultimate impact of the technology on the environment gains recognition, the sociocultural dimension of the impact has tended to be ignored in the mainstream science discourse in education.

Notwithstanding the environmental problems and the increasing poverty in Uganda, the educational system continues to embrace and foster the values of the complex civilizations of the industrialized nations oblivious of the realities of its own people (Olupot, 1995). In various educational discourses, development, which is equated with progress, is thought to be manifested in the advancements of science and technology. Among poor nations of the South, as elsewhere in the world, the grand and irresistible assumption seems to be that innovations in science and technology are universally good, and that their contributions to better living will be accepted as equally desirable and accessible to all peoples in every part of the globe. This assumption has tempered the campaigns of education for all. Peace and development educators like Hicks (1988), Freire (1970), and Toh (1995), however, identify and commend a kind of education which is socially transformative. These scholars identify transformative education as one in which learners are no longer treated as passive repositories of "knowledge" or "truths" from "expert" educators. Its central goal is to alert and liberate learners from naiveté to being critical about assumptions, values and biases of dominant ideologies or knowledge systems, including the increasing unquestioned faith in the culture of modern science and technology and unlimited material progress. Transformative education thus needs priority attention because educators and national planners involved in the pursuit of scientific and technological knowledge and its generation and dissemination are often profoundly yet often unconsciously influenced by the value system of their professional subculture (Sorell, 1991; Chalmers, 1982). From one's student days as a science scholar, the process of socialization begins and the assimilation of motivations, goals and ideas about the "right ways to work" and the ethics of the field are upheld as a standard of excellence. What one has really learned is a particular role in the bureaucratic hierarchy through which the profession is organized for action. An uncritical acceptance of this professional point of view carries great implications for one's role as an agent of change in educational engagements, especially when working with various majority indigenous groups who have upheld a constellation of cultural norms and values.

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[2] *Culture is assigned the meaning in an anthropological sense: a dynamic system of norms, values, and mental representations which specifically identifies a social group and the characteristics through which its constituency identify themselves as insiders, regulate and guide their ways of living, thinking and acting (Thomas, 1958). Understood in this way, culture is structurally represented while being in a process of continuous reconstruction and deconstruction.*

When it comes to shaping education and its role in development, a number of ethical questions arise. In particular, to what extent is science and science education responsive to sensitivities and needs of the majorities in Uganda? As Apple (1996: 5) notes,

> Educational work that is not connected deeply to a powerful understanding of these realities... is in danger of losing its soul. The lives of our children demand no less.

The critical and transformative foundations espoused by Apple and other educators like Freire are clearly those which allow marginalized groups including women to emerge as critical, social actors on the stage of human and ecological transformation and sustainable survival. Furthermore, the conceptual frameworks that purport to uncover and transform the constructions of subjectivity need to be purged of various biases like sexism, Eurocentrism and consumerism.

Teaching and learning processes which embrace the rigid scientific method and support segregative participation take advantage of the students' complying environment and thus fail to embody or reflect their cultural domain. When education overlooks the practices reminiscent of collective understanding and participation and the natural ecological processes which dominate the traditional experiences of African children, it raises critical questions as to the benefits derived from an appreciation and infusion of indigenous knowledge. Omission of and total disregard for indigenous knowledge can be problematic in nations with a rich cultural base like Uganda. This is also pertinent in relation to environmental concerns such as energy consumption, waste management and utilization, handling of hazardous products, food harvest losses and storage, and nutrition. As Bapasirichote (1988) informs us that the development of indigenous knowledge can be fundamentally helpful in guiding choices within science, technology, the social framework, and ecological setting in which they are applied. This is a critical concern for environmental sustainability and associated problems of sociocultural dislocation.

The concern of this study is that the exclusion of the learner's historical domain from the scientific process could lead to an evolution of a society which places its primary credence and faith solely on the rational faculties of humanity. Exclusion can also foster the creation of a society which no longer honors and reveres nature, but instead misuses, abuses, and disrespects it (Schumacher 1973).

Before its exposure to the Western lifestyle, the Ugandan indigenous peoples had developed their own knowledge system as well as ways of knowing and doing things which served their purposes for generations. New ways of knowing, organizing, valuing and acting in the natural environment were thrust upon the indigenous population through contact with western culture, a process which was easily facilitated through the introduction of the formal education system by the colonizers. Because dominant forms of knowledge, science and technology in particular, target the control and domination of nature (Capra, 1982), material accumulation and technological intensive development activities have begun to show detrimental effects on the environmental system.

Development, in the modern view, stems from the conscious advance of dominant scientific knowledge and discourse and its rational application to the design and implementation of better technologies and western social values. In most traditional African contexts however, development was, in the historical context, tied to group success and depended upon culture -- the system of values, beliefs, artifacts, and art forms which sustain social organization and rationalize action (Horton, 1971). In contrast, current schooling among poor nations like Uganda serves to integrate learners into the dominant modern social order which believes in science and its usefulness in national development. Among the South nations, testimony to the belief and trust in science as a panacea is affirmed in a statement by one of the key political leaders among South nations:

> It is science alone that can solve the problems of hunger and poverty, of insanitation and illiteracy, superstition and deadening custom and tradition, of vast resources running waste, of a rich country inhabited by starving people...Who indeed can afford to ignore science today? At every turn we seek its aid... The future belongs to science and to those who make friends with science. (The Prime Minister of India, Nehru, Jawaharlal, quoted in Sorell, 1991:2)

Notwithstanding the potential usefulness of science in the service of humanity and nature, it is necessary to undertake a critically aware discourse in considering this utility. As noted above and later in this report, science has been used to abuse and destroy the integrity of people and the planet. To reverse this trend, scholars like Fien (1990) stress our need to recognize that all educational activities are embedded in some form of ideological background, and that one cannot fully understand the significance or consequence of an activity unless one also considers that activity in light of social continuity and change. Sharing and consensus that builds upon mutual trust in knowledge generation, participation, its uses and implications would function more effectively if it were democratized. In particular, if deeper understanding is to come about through more meaningful and just applications of scientific knowledge, Freire (1994) would argue that it should be derived from the collective synthesis of the people themselves. The ideals of community and their mutual obligations to each other form a superior foundation for the coordination of specialized knowledge such as science and technology, society, environment, and development into something more than what modernity tends to view as independent parts. The above reflections, tied with the insights from the cited scholars, provide a background understanding for the social and ecological responsibility of science as elaborated in the theoretical framework below.

1.3 Conceptual Framework

The next four subsections provide an outline of a theoretical basis upon which synthesis of the study data is made. Central to this conceptual framework is a view of an ecoscience: an interdisciplinary perspective of science which pools modern science, indigenous knowledge, and virtues of social justice, equity, and simplicity as vital tenets for sustainable living of a plural society in and with nature. What the forthcoming sections present are analytic reflections by various scholars which illuminate hope for transformation of the concerns and boundaries of science and its applications. Also provided are philosophical bases for returning science to a humanistic, eco-sensitive and redemptive discourse.

1.3.1 A Transformative View of Schooling and Development

The complex nature of factors in the environmental crisis has compelled a number of concerned scholars and organizations to call for wider cooperation among producers, consumers, government leaders and scientists. According to the World Commission on Environment and Development (WCED) (1988), and Braddock, Fien & Rickson (1994), the task of mitigating environmental problems today demands elaborate strategies that recognize and harness the potential power of interdisciplinary cooperation. A guiding principle for this study was a perspective which focused on various aspects of environmental/science education, including the nature and concept of "environment", transformation in social values necessary to resolve environmental problems, and the role of education in the value transformation process. This study based its view of "environment" not just on nature or natural systems alone but also on environment as a social construction resulting from the process of interactions of social systems with natural systems as people variously extract, utilize and manage natural and social resources to satisfy their needs and wants (Fien, 1990). In this respect, the study sought out views that led to reflections among participants about the nature of the operations of the world economy and international institutions. The issue at hand is whether attention should now focus on the larger economy of life -- the biosphere or (1) the sub-economy built by humans through the exploitation of nature -- the extent to which technology and prices can render human economies independent of healthy soils, microbes, plants, animals, forests, ecosystems, and a stable climate and the cultural needs of the people and (2) indigenous mythologies -- our beliefs of our world which are the basis of concrete practice in our societies (Orr, 1994; Roszak, 1992; Fromm, 1973). This study is premised on an emerging understanding that what a society proclaims to know about the natural world comes from its social constructions which have been shaped and upheld by the cultural and linguistic frames since time immemorial. For this reason, the study has acknowledged and employed a sociocultural framework based on African indigenous interpretations of reality.

As Keller (1992) and other scholars like her have argued, world views and hence language simultaneously reflect and guide the development of scientific models and methods of knowledge production as well as determine how these form a backdrop into the predominant definitions of, and aspirations for, 'development'. These views also help to shape scientific aims, if only because people tend to gravitate towards problems they are equipped to formulate and solve. World views expressed in language are not value-free. What counts as usable, effective, and communicable representation is constrained by our social, cultural, and disciplinary as well as by our ecological locations (Proctor, 1991; Dewey, 1990). The world view of scientists is therefore not only limited by what they learn to think and say as individuals, as members of a discipline, and as members of a community, but also simultaneously restrained by what they can do individually or collectively in their ongoing material interactions with the objects of their inquiry. Another inspired scholar, Capra (1982), in his analysis of the systems view of life, detailed how ecosystems in balance can live together in a combination of competition and mutual dependency. He described how living organisms in nature are characterized by both cooperation, through coexistence and interdependence, and competition, which takes place in a wider context of cooperation. Thus they are successful in keeping the larger system in balance. This systems view of life sharply contrasts with the mechanistic techno-scientific view which promotes competition and control and legitimizes the sustained exploitation of nature and marginalization of other groups. The challenge for scientists and science educators is to frame a humanistic and ecosensitive scientific discourse and construct applications which can also serve the interests of the culturally diverse groups in the South. Holistic vision and interpretation of our coexistence on this planet and our empathetic interactions with other peoples and subsystems of creation cannot be fully understood without reference to the social, cultural, political and economic values of our societies.

Uganda is not unlike many places in the world where competing views, particularly among the "schooled" and "the unschooled", may exist in relation to the interrelationships of society, knowledge, technology, environment and development. The introduction of formal schooling into the traditional cultures from the period of colonization to the post-colonial era ushered in forms of knowledge which some scholars like Olupot (1995) argue as having strongly influenced people to model modernization values. In this respect, colonial education created competing forms of values, attitudes and a social hierarchy which has developed in line with the industrialized countries' dominant forms and sources of knowledge about social reality. This model has now tended to be adopted without question among the post-colonial nations in the South.

1.3.2 Cultural and Ecological Dimension of Development

The prevailing view among the proponents of science and technology is that modern science offers principled explanations while modern technology provides effective solutions to the problems that have troubled the human race from its origin (Borgmann, 1984).

Such views of technology may conflict with many others that have been developed. One interest of this study was to establish a sense of technology which is not necessarily superior or privileged, but instead provided a conceptual framework which draws on the insights and experiences of a range of citizens. I sought to gain an understanding of the paradigms of science and technology from the perspective of various actors to reveal how science and technology has been used in successful or debilitating ways in the various people-environment interactions and their aspirations for its use in the future. Premised on these concerns, this study sought to understand the position of science and technology in the lives of Ugandans, by having the participants turn explicitly to those forces in their lives that have been benefited and/ or endangered by modern scientific and technological development.

If the goal of science and technology is to give humanity systematic control over nature, there is a need to be concerned about the legitimacy of the social constructions of science and technology as devices that potentially threaten the very existence of humanity and the environment. This inquiry was also motivated by minimal research on the value and potential contribution of indigenous science and technological knowledge to the question of sustainability in Uganda. In many countries, the description and documentation of indigenous technological knowledge, particularly in ethnographies, have not examined the subject in relation to development or rural communities (Gomes, 1988). It would appear that such studies on indigenous knowledge have given very little consideration to inquiries into the quality of people-environment interactions and their indigenous knowledge cosmology.

In his study of the history of psychiatry in Malaysia, Woon (1978) (cited in Gomes (1988)) notes that folk medicine, for example, forms a foundation to practices which are potentially complementary rather than contradictory to modern medical systems. Woon also advocates the extended use of such indigenous technological knowledge and skills in other spheres of medical practices. He points out the importance of research on indigenous medical knowledge, and notes how indigenous knowledge and practice is supportive, personal and holistic in approach. Woon posits the humanistic dimension in indigenous medical science practice as strongly contrasting with the typically mechanistic, impersonal, organ-oriented, authoritarian and individualistic approach of modern scientific medicine. Woon's advocacy seeks extension to other aspects of the interactions between modern science, technology and sociocultural perspectives and practices. The growing concern for the welfare of the people demand an urgent search for alternative frameworks of analysis of the ecocrisis that capture sociocultural perspectives. Such pursuits require scientists and science educators to lead the way for the reintegration of local, national and global realities, and reflecting on how these realities might be transformed for ourselves and others living in value-systems and structures of violence, injustices, eco-destruction or other human rights abuse.

In some parts of the world there is an emerging movement among scientists which has embraced the perspective of science and technology as an integral part of the unity of life. A notable example is Islamic science which gives weight to environmental ethics. According to Bakar (1991), the cosmic reality of Islam envisions three states of existence, namely the material, animistic and spiritual states. The natural world is viewed as comprising both material and animistic states, with humans and other life forms belonging to the animistic state. Humanity is also viewed as a form of life having the potential to attain spiritual realization and hence unity of life (Al-Faruqi, 1982). These scholars view human beings as having a social responsibility towards the total environment, both in the biophysical and sociocultural dimensions. In their view, science as a human activity must be subject to the moral philosophy of social organization including religion. Within the Islamic faith, scientific inquiry encompasses unity, trusteeship, worship, knowledge, praise, blame, social justice, tyranny, public interest and waste. In this framework, Sardar (1988) envisages an environmentally friendly science as one which springs from an understanding that all knowledge is potentially destructive physically, materially, emotionally, culturally, spiritually and environmentally. He extols a view of science which promotes social justice and considers public interest to be important, friendly and praiseworthy. A form of science and technology which promotes alienation and dehumanization, consumerism and concentration of wealth in the hands of the few, unemployment and ecological degradation is viewed as tyrannical and blameworthy.

The violent Islamization of the world of Islamic fundamentalists, which is attempting to establish a moral hegemony over non-Muslims, should inspire us all to recognize that a truly humanistic science and technology can only draw its total legitimacy from the collective moral authority of all interest groups in society. To Rose (1986), this calls for the democratization of science, with its core values contextualized within the belief system of every cultural and interest group. In contrast to this socially, culturally, spiritually and environmentally guided form of science inquiry, educators have tended to view science as either a culture in its own right, as Brockman (1995) advocates, or as transcending culture. Educators in particular have tended to focus on the careful explication of scientific concepts -- what Hills (1989) has dubbed 'domestic affairs of science education' (p. 183), leading to the view that science curricula are readily transferable. What becomes evident is an absence of effort on the part of educators to help students make sense of science concepts which are often quite foreign to their context.

As Hodson (1993) notes, teaching and learning science is a cross-cultural activity. The implication is that science educators must continually seek an understanding and an accommodation of these cultural backgrounds and premises in the learning and application of science in various cultural contexts. The absence of cultural relevance in curriculum materials and approaches discriminates against indigenous learners' cultures for whom science has been framed within a dominant discourse; it does not automatically "fit" non-Eurocultural children (Matthews & Smith, 1994). While educators in non-Western developing nations share a strong interest in the development of highly scientific and technological literacy some critical questions are rarely raised about the sociocultural and ecological impact of such an advancement. According to Ogunniyi (1988), these relate to the fundamental questions about one's understanding of the natural world, one's relationship with nature, and the whole notion of causality. These are central questions about world views: the compatibility and tensions between non-Western world views and modern science. Ardent believers in value-free science and education, like Musgrove (1982), have argued that a successful education is one which lifts children out of their culture and assimilates them into the western conceptual system, not least, those of science and technological significance. Such opinions reflect a myopic and inherently racist view of culture and science, where traditional cultures are not only regarded as different but also tacitly assumed to be less rational than modern Western culture. To Hodson (1993), a renowned advocate of multicultural science, the teaching of science should be particularly sensitive to the intellectual environment of students. This is particularly crucial for developing nations like Uganda where science courses have been developed on western models, undergoing little or no modification, and continue to be tied to foreign goals in science education.

The crucial dimension of mitigating a decaying environmental quality presents an equally great challenge to science and technology education. This point is well-illuminated by Braddock, Fien & Rickson (1994) who argue that disciplinarians in science and other areas must be brought together to work on interdisciplinary processes, experimental methods and exploration of values that relate to environmental programs. These scholars' informed background in environmental education and the complexities and cross-curricula interdependencies convincingly cautions us about the challenges of multicultural and interdisciplinary border-bridging. They throw out the challenge to individual academics and to the university and school administration to foster communication across the disciplinary institutional milieu upon which dominant academic programs and structures rest. The major task undertaken in this study was the solicitation of views on the cross-cultural and ecological construction of science in Uganda. Such a construction sought interpretations and views of indigenous elders in which it is reasonable to expect culture-specific framings of science.

1.3.3 Sociocultural Perspectives and Democratization of Knowledge

The modern scientific world view appears to be formulated, according to Capra (1982), to study and analyze objectively learned facts for the purposes of predicting and asserting control over the forces of nature. According to Stake and Easley (1978), science can be conceptualized as inquiry, explanation, or technology. Gould alludes that "science must be understood as a social phenomenon, a human enterprise, not the work of robots programmed to collect pure information" (1981:21). For students from traditional settings therefore, a typical disciplinary approach to the teaching and learning of modern science could present an impediment to their learning since the focus is on compartments of knowledge which are completely isolated from each other and the surrounding universe. An indigenous student is estranged by the domineering, manipulative aspects of dominant model of science and technology (Capra, 1984; Franklin, 1990) which is often contradictory to indigenous views of identity vis a vis community and the environmental system.

Traditional peoples have survived, to a large extent, as members of groups with cultural traits selected like genetic traits; group success is highly dependent on culture -- the system of values, beliefs, artifacts, and art forms which sustain social organization and rational action. In order to seek possible strategies for strengthening both their local as well as global situations, one must understand the importance of communities and learn how they accomplish their goals. The concept of community, as used in this study, includes the large variety of ways in which people associate. There is a tendency to regard communities as structures instead of thinking about the processes, forms of discourse and relationships which make them a reality. The structure of communities cannot be maintained when inappropriate processes are in place.

Knowledge production is a daily reality among the rural folk in most countries. It is knowledge derived from common sense, causal empiricism, and thoughtful speculation (Lindblom & Cohen, 1979). The learned, however, tend to exclude the common knowledge of ordinary peoples. Yet the more people involved in knowledge production and analysis leading to problem-solving, the more likely the interpretation, and in particular the application of knowledge, will be more accurate (Hall, 1988) and more appropriate. Such an understanding could become a process for facilitating the democratization of knowledge. The absence of democratization in scientific discourse tends to facilitate preeminence of a *status quo* which perpetuates the center's role in conserving, modifying, and disseminating knowledge. The linear cause-effect epistemology which is central to a culture of science permeates modern institutions and is held in high regard by policy makers in developing countries like Uganda as a means of evolving a "progressive" economy and society. The democratization of science could therefore make more accountable the behavior of "experts" and influence their use of knowledge towards sustainability for future generations.

Another major concern of this study is the degree of understanding by indigenous peoples of the threats to their survival from the daily actions of development-related activities. There is also the question of whether the indigenous people[3] have the prerogative to facilitate change, if and when there is a need.

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[3] *Rural or traditional communities.*

According to Habermas, knowledge is produced by the ways in which people orient themselves to the world (Carr and Kemmis, 1986). Carr and Kemmis describe Habermas's three spheres of knowing as the material or technical, the interpretive, and the critical-reflective orientations. The orientation towards material well-being is governed by a technical interest in acting on the world, and this form of 'knowing' is empirical, characterized by generalizations and factual knowledge. An orientation toward communication is governed by a practical interest in understanding others and the world around us and is characterized by situational interpretations. The orientation toward freedom, governed by an emancipatory interest in liberating persons from oppressive situations, leads to the generation of critically reflective knowledge.

While each of these forms of knowledge has its own sphere of relevance, there are tendencies for a technical interest to dominate the whole social discourse. The outcome is the generation of highly consumer-oriented societies who now hasten the depletion of environmental resources (Gore, 1992; Norgaard, 1994; Redclift, 1984; Berry, 1988). Modernity, basically a technologically-oriented world view encompassing the period of the industrial revolution in the seventeenth century to the present, considers knowledge as immutable, pre-existing, unchangeable and discoverable by people through rational process and empirical method (Doll 1993). The danger of this orientation is the potential belief that, by using technological rationality, humanity can apply this knowledge to human endeavors for the control of the world in their interest. This world view has already created relations of domination and control whereby people have been treated and manipulated as objects rather than subjects who have the capacity and creativity to determine their own destiny.

On interpretive knowing, Carson (1990) cautions that while it is essential to acknowledge the meaning of actors in human relationships, it can be inadequate for the task of liberation and emancipation. The danger, Carson notes, lies in the possibility of the manipulation of people's understandings, making them easy prey for domination. It is at this point that critical theorists advocate a sustained critical reflective discourse in order to create communities which are able to operate in the domain of reason and democratic decision-making instead of being unduly influenced by unequal power.

Modern science and technology are more than ways of knowing. They consist of particular practices, methods and ideologies. According to Franklin, "scientific method works best in circumstances in which the system studied can be truly isolated from its general context" (1990:39). This isolation is explained by Nollman (1990:74) who points out that "the objective viewpoint cannot perceive the context of the whole because the objectivists themselves insist upon utilizing only part of ... the whole". This viewpoint places a perpetual buffer between our conscious thoughts, our connection to nature, and in particular to the environmental system. When modern science emphasizes what Habermas terms the "material" or "technocratic" orientation, it has the potential to promote the compartmentalization and specialization of scientific knowledge as separate disciplines.

Often these disciplines are decontextualized and taught in the detachment of a classroom or laboratory setting (Franklin, 1990; Stanley & Brickhouse, 1994). There is also a traditional dimension to curriculum which was brought about by the history of education in a country like Uganda. In most institutions in Uganda, curricula have either been inherited from colonial systems or imported or adopted from other countries without due consideration or investigation of the forms of knowledge or purposes such curricula will serve, reinforce, or inhibit in the local context. This raises a critical question about the extent to which the science curricula are endogenous. More emphasis on the local context does not necessarily mean less emphasis on the global. For environmental issues, governance at national level is less critical than at the local, regional and global levels. It becomes imperative to reflect on a point raised by Norgaard (1994) that modernity, as espoused by the industrialized countries and emerging nations, has promised a merging of cultures around a science which would master nature and rationalize social organization. Bell (1973) also acknowledges that for generations, Western and "Westernized" peoples -- the elite -- have lived and behaved in accordance with this expectation. Development in the modern view therefore stems from the conscious advance of dominant western knowledge and its rational application to the design and implementation of better technologies and social organization. The idea of progress is implicit in the modern view, with modernization entailing a continual substitution of formal institutions and objective knowledge for culture and cultural knowledge as we commonly think of them.

1.3.4 Coevolutionary Framing of Knowledge

Coevolution is an explanation of process that could become an integral thread in the fabric of a new great life story for society (Schwartz & Oglivy, 1979). The coevolutionary cosmology stresses the communal nature of knowing, in contrast to research which views knowledge as a means to control and dominate people and nature. Norgaard (1994) explains that a coevolutionary perspective views social life as a process of sharing rather than vote-counting and enforcement or technocratic determinism. It emphasizes the beauty of participating in and sustaining a coevolutionary unfolding rather than the individual glorification of power and material accumulation. It values both nature and people as integral parts of nature. The coevolutionary cosmology draws upon recent advances in modern science as well as upon values which have withstood the test of time. And most importantly, it gives legitimacy to a philosophy for interaction within the plurality of evolving human cultures and their distinct yet changing life stories.

A coevolutionary cosmology provides a basis for explaining how history unfolds by highlighting how the exploitation of natural resources like fossil hydrocarbons have driven a wedge between the coevolution of social and ecological systems. In contrast, the modern explanation of process stresses a cultural merging of universally accepted knowledge, values, ways of organizing, and "best" technologies. Modernity fosters global homogenization, centralization, and a hierarchy of experts, while a coevolutionary view complements a vision of diversity, sharing, and richness. In this view cooperation among groups should be rooted more firmly in the nature of shared problems and less in the rhetoric of the global community. The view of this study is that a coevolutionary perspective is desirable and needs to be pursued in science and science education because it offers greater hope for synergistic action between people and nature. Our understanding of the relationships between social and environmental systems affects how we choose to behave individually and how we organize to behave collectively. In turn, the choices we make influence the forces and selective pressures we place on the environmental and cultural subsystems (Futuyma & Slatkin, 1983). Our understanding also has a tendency to direct the way in which we participate in the unfolding of the future and is highly dependent upon the understandings we hold about the past and the present.

After decades of social, political, and economic upheavals -- none at all deserved -- Ugandans, more than ever, need reassurance that education, particularly science and science education, are capable of dealing with crucial national issues of survival which are intimately linked to environmental sustainability. A coevolutionary interpretation of scientific and indigenous knowledge, values, social organization and technology could yield a working conceptual framework and an epistemology which would foster better understanding and conniorssuership. Such a framework would sharply contrast the mechanistic, technical and predictive forms inherent in the sciences today which are directed towards control and domination of nature. This study also submits that our understanding will change as coevolutionary process helps us to understand why the current model of modernity has fueled the environmental crisis and undermined sustainable development.

As Futuyma and Slatkin (1983) have stressed, every aspect of the ecosphere is connected to everything else across species and across time. The concept of coevolution raised by Futuyma and Slatkin ultimately consists of looking at evolution as a coevolutionary process. In the perspective of this study, coevolution need not be limited to the ecology of living things. Its framework could be used in understanding and shaping --

in the interest of equity, justice, and sustainability -- various domains of discourse including the interactions between social, economic, political, scientific, technological and the ecological systems. This expansion in thinking will complement existing understandings that, largely through the study of natural history, that ecosystems were tightly interconnected, and species ideally suited for each other (Aldo Leopold, 1949). While evolutionary thought upholds a formal structure within traditional science, the more broadly interpretive pattern of thinking explains and lends legitimacy to other ways of knowing. The traditional knowledge of most indigenous people, for example, fits well within the context in which they evolved. The division between natural and unnatural is embedded in our modern understanding of nature and development. The view of this study is that, if pursued on the basis of the coevolutionary perspective, environmental transformation could benefit people and accord opportunities to increase species biodiversity and cultural pluralism which is harmoniously linked to a sustainable environmental system.

Any framework which has been highly elaborated to stretch its usefulness can only be understood by a few who are well-informed of its technical details. On this point, Brenann (1990) alludes that the use of a single framework, in societies like Uganda which have adopted a modern world view, facilitates the tyranny of technocrats, encourages centralization and thereby disenfranchises the majority. Openness to multiple frames of analysis is a prerequisite to democracy, local control, and accountability. The degree to which "modern" forms of knowing, technological intervention, and social organization have been adopted could either enhance or reduce cultural and biological diversity, depending on the degree of integration and on the resonance of the modes of knowing, as well as the interdependence of people-environment systems.

The view of the study is that the approaches highlighted in the conceptual framework, namely the modern and sociocultural world views, are potentially reconcilable if the emphasis is placed on meeting the needs defined within a culturally diverse social milieu, and if due attention is given to raising the awareness of issues of equality, justice, and power. Embedded within the coevolutionary framework would be a holistic revisioning of science which could embody a number of different perspectives of environment and indigenous knowledge in science. It is hoped that conscious pursuit of such conceptual diversity in science can facilitate a complementary and coordinated effort towards sustainability of people-environment harmony. Recognizing perspectives which acknowledge and reflect environment and sociocultural concerns in science and science education could provide an expansion of research into plural frameworks used in indigenous knowledge systems, particularly the concepts of environment, development and sociocultural survival. The approach and concerns of this study were, in part, an impassioned response to the tendency among educators, policy makers, decision-makers and people in power to use a mechanistic "cookbook" approach to develop and/or prescribe policies and practices in the absence of a grounded understanding of the environmental, sociocultural and political dimensions of the situation among the populace.

The study therefore sought to facilitate the cross-fertilization of ideas among the academics at Makerere University and the indigenous people in Tororo. To this end, the study sought to provide room for dialogue on the role of education, science and science education in relation ecological and sociocultural harmony, and explored strategies to inspire and re-direct curricula and teaching methods within formal institutions towards the concerns of the majority and to the mutual benefit of both the indigenous people and dominant science (Freire 1970).

1.4 Statement of the Problem and Research Questions

The issues and problems related to environmental sustainability have recently captured the attention of many governments, ecological movements, as well as individual researchers from diverse fields. It has become quite clear that, without effective understanding of and intervention in the functioning of knowledge and world views upheld not only in educational institutions but also among indigenous cultural groups, the ability of environmental resources to sustain survival on this planet could be drastically curtailed. Environmental pollution, land degradation, disappearance of animal and plant species are some of the serious symptoms currently threatening the world's populations, particularly in the South. Modern explanations of the relationship between development and environment have stressed how science facilitates technological innovations for discovery of new natural resources. This age is being called the scientific age. According to Sorrel (1991), scientific knowledge is considered the only acceptable form of knowledge, and problem-solving is dominated by rational thought.

Intuitive knowledge, awareness, and cultural or indigenous knowledge, values and technologies which are just as reliable appear to be losing recognition and validity. The extent to which sociocultural and scientific knowledge will pervade the educational and social systems in the developing nations, including Uganda, could have pivotal effects in determining appropriate education. In particular, science plays a critical role in the cultural survival of the majorities whose livelihood is directly pegged to the quality and capacity of the natural environment to sustain them and in the development of critical environmental awareness and management. Against this background educators in emerging nations, mindful of development, should become increasingly concerned with the relationship between curriculum, pedagogy and the basic needs of the world's majorities whose entitlement to food, water, land and other resources have already been severely constrained by national and international development policy.

The Rio Conference of 1992 clearly called for an environmental agenda which, in my opinion, signaled a great educational challenge for the reversal of the malignant 'modernistic' notions of development.

Environmental pollution, land degradation, disappearance of animal and plant species are some of the serious symptoms of the current threat to Africa's population.

Crucial in this study were the need to investigate the perceptions of scientists and science educators, to focus attention on the role of science and science education as mechanisms to sharpen and sensitize human intellect towards critical understanding of the relationship between development and environment, and to identify possible solutions to the environmental and sociocultural problems. The study set out to identify the consonance between science and its envisaged role in society as perceived by the university academics in Makerere University and the forms of knowledge, values, and actions in the environment among the indigenous people in Tororo as they constantly negotiate for a way of life consonant with themselves and the natural resources around them. The provision of premises for the analysis and clarification of their own values and interests active in their respective engagements arose from the sharing of views and concerns among the university science academics, government officials, and the indigenous people of Osukuru community of Tororo District. The following questions underlying this study guided these discussions:

> What sociocultural premises underlie ecologically sustainable and socially just ways of organizing and acting in people - environment relationships?
>
> What role is, or can be, played by science and science education and with what professional beliefs, assumptions and practices, to encourage and contribute to socially critical objectives that underpin environmentally conscious development activities in Uganda?

The study availed an opportunity for its participants to situate issues and questions about science and its technological ramifications, environment and development in Uganda in dialogue with their lived experiences: the positives and negatives in each setting; the contradictions, assumptions, resistances, and suppressions embedded in various practices.

In this way, the study identified the views and possibilities of how both contemporary scientific knowledge, appropriate technology considerations and indigenous insights can be revisited to embrace a holistic framing which could recognize and ensure diversity, interdependence, empathy, equity, respect and love for people and environment.

An observable tenet of education at all levels in Uganda is its focus on summative evaluation, objective exams in each discipline, and career-oriented goals. As a sole educational goal since the onset of formal education and the driving force behind teaching-learning strategies, this raises questions about influences which led an educational system to ignore and/or misrepresent the national planning objectives which educational institutions claim they support. It is claimed that science can enhance development as it has been done in the industrialized nations. So in the Ugandan context, the study was interested in the relationship between indigenous knowledge, particularly indigenous scientific knowledge, and modern science. In a quest for development education therefore, the study sought dialogical responses to the following questions: What are the ways in which these two types of knowledge contradict and or complement each other? How should a science curriculum in Uganda posit Agenda 21 which requires the stabilization of climate, reduction in population, reversal of loss of forests, protection of biodiversity, conservation of soil, reconstruction of rural areas, clean-up of toxic waste? How can Uganda become more efficient in its use of energy? And, can we make a rapid transition to solar-based technologies, stabilize and sharply reduce poverty, social inequity and injustices?

Modern explanations of the relationship between development and environment have stressed how science facilitates technological innovations for the discovery of new natural resources to meeting increasing levels of need and satisfaction. Science has proven effective in meeting many of the goals set for it, but it was also the intent of this study to investigate the force and efficacy of these representations in the Ugandan contexts by examining critically what scientific knowledge has achieved. It is also imperative to ask whether a science which evolved from western social needs and imported from industrialized nations can develop in the Ugandan (African) context. Or should science develop from methods that are culturally functional in our context and linked to problems that are socially defined in our reality and the kinds of issues that are centered to self-directed development? The study sought to go beyond this point by looking at the pedagogy itself: Upon what foundations does Makerere University's science curriculum rest? What does this curriculum implicitly and explicitly teach about local traditions, indigenous knowledge, and/or traditional approaches and perspectives to environmental care? How should university academics conduct their teaching and research in science and science education to ensure that students and communities are self-conscious of environmental issues in their respective life engagements? Without seeking to repudiate science or its replacement, but wanting to establish its location and reclamation as a human and natural project, the study engaged the views of its participants in dialogue with available scholarly frameworks. In this way, the study explored the renunciation of the division of emotional and intellectual struggle that propels the dominating and controlling drive of science against nature and its tendencies to be exclusive of some sectors of society (Berry, 1988; Oelschlaeger, 1995; Adams, 1993). The study's interest on the operations of the world economy allowed participants to engage in dialogue on whether attention should now focus on the larger economy of life -- the biosphere[4]. The study recognized that the knowledge a society proclaims to possess about the natural world comes from the upheld social constructions which have been shaped by the cultural and linguistic frames (Roszak, 1992). For this reason, the study made extensive use of a sociocultural location based on African indigenous framings of reality.

To articulate educational implications of this inquiry, I have pursued a curriculum perspective -- a concept of knowledge production and dissemination -- and how it evolves a society through discourse and attitudes that empathize and promote grassroots basic needs on sustainability basis. This directed the search for answers to the following questions: Does science, as practiced in Makerere University, bring the material world into closer conformity with the stories and expectations of the majorities? Where and how do the forces of beliefs, interests, and cultural norms enter into the process by which effective knowledge is generated? Where and how should nature enter into this process? How do nature and culture interact, if at all, in the production and utilization of scientific knowledge in formal schooling? What alternative conceptions of science and technology could be sought to make sense of the *world* in an African traditional context to make the successes of these theories highly local and specific? Universities as centers for knowledge production and dissemination have purported to address these questions. Institutions of higher learning in several South contexts that are geared towards the production of scientists and technologists should feel challenged to tailor their curricula towards a development model that fosters environmental sustainability. In particular, centers for science, science education and environmental institutes in post-secondary institutions should be at the forefront in championing what is regarded as a noble vision of university education through churning out the "personnel" needed by individual societies to harmonize their coexistence with the environment. The responses evolved from this study were reviewed and interpreted on the basis of various insights from scholars who have researched on environment, science, and science education particularly in the environmental/sociocultural contexts. Through this process the study laid out avenues upon which frameworks for understanding and revisioning science that incorporated sociocultural perspectives of knowing and acting.

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[4] *As opposed to (1) the sub-economy that humans have built by exploiting nature -- the extent to which technology and prices can render human economies independent of healthy soils, microbes, plants, animals, forests, ecosystems, and a stable climate and the cultural needs of the people; and (2) indigenous mythologies - our beliefs of our world - which are the basis of concrete practice in our societies (Orr, 1994; Roszak, 1992; Fromm, 1973).*

1.5 Significance of the Study

In its concerns for the role of science and technology in sustainable ecological balance and development in partnership with indigenous cultural knowledge, the study has placed an understanding of planned scientific and technological change in a broader perspective. For this reason, the underlying processes capture, as they should, the aspirations of the indigenous majorities in the development for a sustainable future. A university, government offices, and a traditional rural community were used as the setting for the study as they are the acclaimed targets of Ugandan development policies and programs which seek to move the country out of "primitiveness" and "backwardness" and into modernization.

Little research has been carried out with the underlying purpose of linking indigenous knowledge system to formal educational institutions. What is known about indigenous knowledge, if anything, is mainly its contents (Gomes, 1988). But very little is known about its structure or theoretical base in terms of, for example, how it is embedded in the environmental and sociocultural context; and, historically, cultural research issues have been accorded solely to anthropologists. Environmental literacy and its sustainability is clearly an interdisciplinary concern. The role of other disciplines in the research effort becomes important and urgent in pursuit of holistic understanding and programs which are designed to bring about coherent social transformation. Considerations of people's knowledge and technology and the way in which they are mutually harnessed to inform and mediate people's interventions and iterations in the natural environment in selected Ugandan settings were central to the investigations of this study.

The motivation for this study was to initiate ways to functionally and interdependently link the formal science curricula of Ugandan educational institutions with indigenous knowledge, values, and organizations which provide a better understanding of forms of interventions in the environmental system. The development of a new consciousness constructed on indigenous identity, appropriate scientific knowledge, and a cultural mix of useful values, traditions, and customs could go a long way toward alleviating the physical and psycho-social problems most indigenous societies face today (Gamble, 1986). In addition, this combined knowledge would help these communities to find their place and role in the world at a time when an awareness of the environmental system as the sole base for livelihood for the majority in the South is emerging.

Historically, the study of our values, habits, customs, and belief systems as a people has been left to academicians and professionals beyond the Ugandan borders. Likewise the search for the "solutions" to our problems, particularly those of environmental nature, has gone outside the country. This dependence on the "invisible hand" totally ignores the capacities and inherent potentialities among the masses, and in the local traditional values and norms (Gamble, 1986). This approach, particularly to African societies, is flawed because foreign knowledge constructs, values, social organizations and ideologies adopted from the outside are essentially alien and often inconsistent with indigenous ways of knowing and interacting. To achieve a meaningful quality of life which can balance between human needs and wants with sustainability of the local natural environmental system requires the democratization of science in terms of generation and encouragement of local, individual and group input and participation; this is an important seed to plant. This study challenges the perception that an effective re-imaging of the future should be pre-determined by a few individuals in hierarchical institutions who have based their description of a better world on a simple list of agreed upon objectives. This study further availed participants an opportunity to reflect on how such objectives could be translated to appropriate procedures to meet the needs of the majority. With increasing pressures on the environmental system, the rural majorities who subsist on it need a more elaborate and less mechanistic line to their story for a meaningful, valuable and sustained coexistence in their environmental system.

Central to the insights sought among the participants was the concerns for the kind of world needed for today's children and those to come, and the kind of culture needed to achieve this. What kind of education, what nature of curriculum and conceptual frameworks would be needed to achieve this kind of education in Uganda and facilitate the development of this culture?

1.6 Scope of the Study

The intent of the study was to inquire into how the university science and science education academics, on the one hand, and the rural indigenous people in Tororo (Osukuru Parish), on the other, perceive (scientific) knowledge and its role in shaping people's interactions with the environment. It was also the intent of the study to seek out how the university academics explain or rationalize the environmental problems and examine their perceptions of the role of science in fostering, creating and/ or mitigating the environmental degradation and social deprivation in Uganda, and globally. The same intent was used among the indigenous peoples. The study sought to discover their perceptions of the environmental problems surrounding them, their explanations, rationalizations, and how the government, in its facilitation of participatory endeavors, has drawn upon their knowledge, cosmology, social organization, values and agency for sustainable use and management of what is central to their survival. Time constraints as well as conceptual breadth did not allow this study to make an actual inventory of indigenous science and technology and environmental management domains. The exposure gained from this study, however, invites future effort to explore these issues further to gain an understanding of various facets of science, technology and ecological concepts and skills among indigenous communities in Uganda. With the wealth of cultural experience available in this country, future inquiries into the indigenous domains of knowledge and findings which would make meaningful contributions to the enrichment of science and technology programs in schooling would be a useful future engagement.

1.7 Limitations of the Study

The setting selected for the study of indigenous peoples is admittedly small and unrepresentative of Uganda spatially, demographically and culturally. Nor is it representative in terms of the environmental system's diversity and interventions. These disparities may place some limitations on the generalizability of the study's findings. My undergraduate and graduate science education has been wholly modeled on the dominant traditional science perspective which may be at variance with some of the traditional beliefs of the Tororo people. In fact, my academic background could be perceived by some as an impediment to this study due to the influence of avenues of new thought, direction and interpretation of various situations which were encountered. However, this academic background was counterbalanced by personal experience. Careful listening, consultations, and co-reevaluation of transcripts with the participants was employed to minimize personal bias. Building the participants' rapport and awareness on the value and importance of the study certainly aided in eliciting truthful accounts of perceptions, beliefs and experiences as well as sustaining their involvement. The greatest hurdle I encountered involved the transcription of the dialogues from the Ateso language of the Osukuru elders in Tororo into English. In spite of being well-versed in both the Ateso language and culture as a child, I had overlooked the fact that elders speak in images, thus making the translation of some of their narratives quite difficult. An example was the elders' concept of *Kau* which, literally translated, means place of birth and or one's place origin. The way it was mapped out to me during the focus group discussions gave a whole different picture and deeper meaning, to capture the notion of spiritual nucleus about which one's origin was defined at birth and anchored, and to return at death. It was also posited as a place where one needed to continually pay homage and recharge one's energies and sense of identity. So the language of the elders conveyed more than facts and figures. It presented a world, beyond my experience and expectations, which was rich with imagery illustrating a knowledge system deeply embedded among the elders and phenomenally pregnant with meaning.

1.8 Definition of Terms

In this study, some of the concepts used may carry more than one meaning in professional or popular language. While a number of these terms have been defined in the text, the following phrases are defined in the context of this study as follows.

On ***Science Education***, Hodson (1994) has provided three insightful distinctions in. He has pointed out that there is: 1. ***Learning science***, which involves the acquisition and development of conceptual and theoretical knowledge in science; 2. ***Learning about science***, which is directed towards developing an understanding of the nature and methods of science in terms of its assumptions, philosophical and epistemological premises, and an awareness of the complex interactions among science, technology, society and environment; and, 3. ***Doing science***, which refers to the engagements involved in the development of specific disciplinary expertise in scientific inquiry and problem solving.

The perspective of this study captures the first two definitions of science education, as pointed out by Hodson: these are the identification of views and assumptions embedded in science and their concomitant implications for society, technology, development and the environment. This pursuit created a foundation onto the third definition, that is engagements involved in the disciplinary expertise and the acquisition of conceptual knowledge and the associated procedural requirements of science.

Intervention is defined here as a systematic effort to strategically apply resources to manipulate seemingly causal elements in an ongoing process, so as to permanently reorient that process in directions deemed to be desirable by the intervening party. The concept ***indigenous*** is related to being an integral part of a culture. ***Indigenous knowledge*** is a system of values, attitudes, skills embodied in a socioeconomic and spatial location. It is rooted in specific social groups. It may come from outside, but is "stored", communicated and used by its members to serve some purpose in relation to productive activity within society in their environmental system. ***Indigenous learning*** constitutes the acquisition of knowledge and skills in a way that is part of the culture concerned. Such knowledge and skills can be new to the culture concerned; or new but originate from inside the culture; or that which is present in and passed on within the culture. Indigenous learning is also viewed in this study as learning which proceeds endogenously, without intervention.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter is an exploration of some insights from various scholars based on their empirical studies and/or theoretical discussions on the central concern of this study, namely, how science and its discoveries are the dominant forces driving societies today. The reviews in this chapter bring to the center-stage the underlying assumptions embedded in the pursuit of science and technology as a means of attaining the goals of development. The theoretical views and frameworks presented by a cross section of scholars in this chapter raise various arguments, assumptions, rationales and realities regarding the role of mainstream science, technology and education in society and ecological systems.

Modern explanations of the relationship between development and the environment have stressed how modern science and technology have facilitated the discovery of new resources and access to lower grade resources. Inherent in these descriptions and prescriptions of the role of science and technology is a perception of the environment as a pool of resource inputs rather than a complex system that is transformed by development.

In the "developed" world, in spite of the "impressive progress" achieved through the fruits of innovation, life for the majority is still a visibly worsening struggle (Suzuki, 1994; Caldicott, 1995). Alarm has been raised in most industrialized nations over the vanishing forests, acid rain, exposure to high energy radiation due to the depletion of the ozone layer, and ill health from chemical pollution. These and many similar cases cause one to pause and query whether science's unique ways of knowing also have a fatal weakness. Is it safe to sustain the inherent contradictions of adamant and overzealous scientific inquiries which take such a dispassionate view of the earth and the majority of its people? What will be the fate of the millions in the South who still depend entirely on the natural environment for their survival if, through the promotion of science and technology, we all begin to regard the animate and inanimate in our own environment merely as commodities and resources or opportunities for exploitation? What will be the fate of the poor and marginalized majorities when the "bottom line" of priorities becomes control, consumption, material wealth, economic growth and profit through the application of scientific insights? Clearly, science and technology have provided avenues to "break the barrier" from poverty to affluence in all societies; but my task in this study, motivated by some of the reflections encountered in this section, was to pose a set of simple but critical questions: how can we in Uganda, and indeed elsewhere, use education to ensure the evolution of an appropriate science and technology which could break the barrier and return to the traditional stasis of reciprocity? As the planetary crisis worsens, what do educators need to recognize and engender regarding people's estrangement from the environment? How can we find ways to reconnect with the natural world and those traditional cultural practices attuned to its balance? In light of these questions, the next sections provide some insights based various inquiries studies as well as theoretical discussions which explore strategies for developing a new vision of our place in the natural world.

2.1 Science, Technology, Society and Environment

Much of the methodology of natural science[5] is based on experimentation which allows scientists to reduce systems to their elemental composition and control many of the variables in the process, so that they can see how one variable affects another (Chalmers, 1982). The emerging environmental crisis -- the growth of which is tied to many interacting variables such as population, goods production, distribution, consumption, scientific-technological innovations, poverty, disease and violence -- all seem to be drawing the recognition among scientists that prediction and control cannot be applied on such a large scale (Allen, 1980). Scholars like Holling and Prigogine espouse the argument that new approaches in all human discourses including science and technology are essential. To Holling (1978; 1985), these new approaches and responses to changes of living systems and on ecosystems should constitute a science of surprise in place of a science and technology of prediction and control. Ilya Prigogine (1980), in his study of systems' equilibrium, discovered that a system at molecular scale would, under certain conditions, cease to oscillate harmoniously between one condition and another and would instead be pushed out of equilibrium. As a result of this dislocation from stasis, the system would change its structure irreversibly (Prigogine and Stengers, 1984). Lovelock (1988), advancing his Gaia hypothesis, extends Prigogine's concept pointing out that this irreversible change is responsible for the evolution of natural systems. These studies and analyses are based on the physical-biological dimensions of natural systems (Odum, 1983; Odum, 1989). The relevance to this evolutionary paradigm to the study of human and natural systems interaction has also been pointed out by Allen (1980) and Odum, (1983).

Many events today raise questions about whether science and technology have been pushed too far. The depletion of the stratospheric ozone layer is now widely known to lead to the increased risk of exposure to high-penetrating, energy-intensive ultra-violet rays which cause skin cancer in humans and are equally destructive to plants, animals and other living systems (Caldicott, 1990; 1995). Globally, there is heightened fear over global warming, a consequence of increased emission of carbon dioxide, methane, nitrous oxides into the atmosphere. With the in-coming solar radiation, these gases give the atmosphere the properties of a greenhouse (Boeker, 1995; Monteith, 1990) earning them the name "greenhouse gases". The emission of ozone-depleting chlorofluorocarbons (CFCs), the production of greenhouse gases and the discharge of other chemical compounds into the air, soil and water are all a result of manufacturing industries, transportation and power-generation often tied to "wealth creation" (Lazlo, 1994).

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[5] *Science is used here to refer to human activity invested towards production of objective knowledge based on discovery of laws in the various areas of reality, enabling us to give a rational account of events and phenomena. It is through these intrinsic characteristics that science, in its manifestation as technology, asserts itself as a powerful factor for changing reality. For better or worse.*

Threats to humanity and the environment can be attributed to other programs directly linked to science and technology. Witness, for example, accidents in nuclear power plants such as Chernobyl, the deadly gas released at the carbide plant explosion in Bophal, India, and technical failures of mega-million space projects, such as the recent crash into the Pacific Ocean in November 1996 of a derelict space-probe suspected of being radioactive. These growing disasters triggered by the seemingly autonomous actions of science and technology provoke a profound desire to examine the values embedded in scientific and technological processes. Such inquiries could inform decisions about the appropriate directions and discourse of science and technology and a subsequent search for wise limits to technology and to questions about science itself. What are the values embedded in the creation and propagation of scientific knowledge? How do these values frame and limit the science that is so basic to technology? What characteristics of scientific knowledge and discourse make our best efforts at application seem so often to end in disaster?

By seeking a critical understanding of the limits and possibilities of science, people in developing nations like Uganda could become more fully aware of the implications of the government's advocacy of modern science and technology. Both the "users" and "producers" of scientific and associated technological knowledge are entitled to this understanding. Conservative guardians to "disciplinary" framings of science would possibly question whether raising questions of this type is relevant to my 'pure' physics background and to my role as a physics/physics education lecturer at Makerere University in Kampala, Uganda. My brief but intense exposure to the "developed" world and its socioeconomic equalities and environmental problems which abound as a result of advanced scientific-technological industrialization has led me to raise these questions as part of the legitimate concerns of any scientist, educator and citizen interested in the plight of the masses. These issues have or should have great implications for the students and the universities which educate the "experts" upon which society and balance of nature will rely now and in generations to come.

The increasing disparities among people in Uganda arising from competitive development pursuits and the deteriorating ecological systems which threaten the lives of the rural majorities in Uganda are an indication that our education system has neither facilitated a clear understanding of nor an engagement with the problems of Ugandans. It raises concerns about whether the focus of teaching on “pure” science and its “pure” technological ramifications (for purposes of national development) is responsible for casting the gaze of scientists and related professionals away from social and ecological values. Is disciplinary excellence amenable or antithetical to social and environmental good? How could the integration of social concerns, empathy, and the expression of social purpose be constructed into scientific and technological discourse?

Writing on the test of good design, Raskin (1971) strongly points to the need for the designer to “live the project”. Mega-development projects like the Narmada Dam in India by the World Bank (Suzuki, 1994) and the Green Revolution in Mexico, India, and the Philippines (Redclift, 1984) are clear examples of the absence of empathy as an integral part of the science-technology processes, leading to the violent disruption of communities, their cultural identity, and the destruction of the environment as well as environmental-cultural harmony. Raskin's point of "living the project" fields a question to scientists and science educators about whether scientific discourse in schools and its practical applications are socially and ecologically appropriate. To Raskin (1971), what is called for is reconstructive knowledge - a process that should seek to foster a rebuilding of society while bridging and healing the rift between subject and object and between excellence and morality within the communities of scholars, educators, experts and the rural masses in various settings. To meet the needs of the masses as well empower people to stem the forces that are responsible for the ecocrisis, such a reconstruction of scientific knowledge would need to take into consideration two factors. First, opportunities for democratic participation of various affected groups as a means of catering for various interests and concerns. Second, because of the evolving nature of society, a continuous interrogation of the processes involved in teasing out assumptions and underlying values -- making them visible and open to challenge. The dominant hierarchical structures in education have tended to hegemonize[6] people to uncritically accept whatever is said to be “useful” or “true.”

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[6] *Hegemony is used here in the Gramscian perpective of the power of the dominant group to shape the consciousness of the the subordinate groups (Gramsci, 1971).*

The hierarchy which is a characteristic of dominant scientific knowledge has been challenged by some scholars. Tandon (1981) for example cautions that certain specialized forms of knowledge have become the most important basis for power and control in today's world. A number of other similarly-minded researchers intimate similar sentiments. Hall (1979) asserts that knowledge production is now nearly a monopolized industry which excludes ordinary people from the increasingly more specialized and regulated industry. This conflict in various knowledge forms creates a spectrum of worldviews and perspectives, in particular of science, the environment, and what counts as development.

2.2 Science, Technology and Development in Africa

Like other developing regions, Africa has eagerly pursued the development of its scientific and technological capacity as a means to attain self-reliance in the production of goods and services. Numerous forums held by politicians and technical experts in the region like the conference of Ministers of African Member States Responsible for Application of Science and Technology to Development (CASTAFRICA) have been organized under the auspices of UNESCO and Economic Commission of Africa. In its first conference of 1974 in Dakar, Senegal, the conference noted the problem of the implementation of science and technology in Africa as a problem of development and made strong recommendations for the formulation of policies which would help African states achieve scientific and technological progress (Mench, 1988).

Since independence, the dominant theme among African states has been to evolve a minimal science and technology base without which a breakthrough in economic development in the region was perceived as non-feasible. In striving to develop their scientific and technological capacities, African nations have targeted the expansion of their facilities, setting up curriculum development centers, equipment development centers, local or regional examination boards, and in some states, the mechanisms for the formulation of science and technology policy (UNESCO, 1987; OAU, 1981). One impact of this regional campaign is that science is now taught at all levels of education in most African states, including Uganda. The hope is that this will stimulate development and economic growth through the development of sanitation, energy, housing, urban development and growth in the agriculture, transportation and communications industries. During the 1987 CASTAFRICA II Conference in Arusha, Tanzania, the reaffirmation to the development of science and technology was made, but an alarm was also echoed over the rapid deterioration of the environment, increased pollution and population growth, and a rise in infant mortality and illiteracy (UNESCO, 1987). Also noted during CASTAFRICA II was the increasing indebtedness and consequent adjustment policies imposed on African states by the rich industrialized nations and financial institutions like World Bank, resulting in the unsustainability of development policies and the poor management of resources.

From the foregoing, it is apparent that the efforts made by African states to develop their science and technology base have been less than satisfactory. The numerous obstacles to Africa's attainment of its dream of scientific and technological independence are clearly complex, each leading to the other. The international economic depression, the collapse of communism and the focus of foreign donors on Eastern Europe has been perceived by some analysts as having some serious financial implications for the quality of education in Africa. Olupot (1995) has argued that the fragile economic structures in Africa have depended on the terms of trade set by the world market, often to the disadvantage of African states. The fall of commodity prices result in trade losses which upset the budgetary and the balance of payments. Such poor socio-economic conditions have negatively impacted on the funding for education.

However, the critique of African education by World Bank and the International Monetary Fund (IMF) constructed on the recipe of "structural adjustment program (SAP)" is laden with market-driven philosophies and neo-conservative economic policies of the industrial nations. Worsening economic conditions, the collapse of infrastructure, corruption, environmental pollution and degradation, reduced educational funding, and even increased political instability have been identified as some of the effects of (SAPs) (Brown, 1995; Mench, 1988; Ogunniyi, 1991).

From the perspective of the World Bank, African universities are producing, at high cost, an abundance of graduates of poor quality and limited relevance who make no contribution to new knowledge (Times Higher Education Supplement, 1991). What seems evident in the failed efforts of African nations' development of their scientific and technological capacity is the disregard and/or the inability of existing structures to cope with the development of indigenous science and technology.

The ineffectiveness of present science and technology education to provide learners with critical skills for development is due to inappropriate socio-cultural settings, the negative impact of imported science and technology, and the rural/urban, male/female dichotomy in science and technology. Historically, changes in the science and technology curricula in Africa have been derived from the industrialized nations, instead of identifying their own unique paths to their own future. For each African nation, the effort for innovation in curricula were made with a view to developing and directing the goals of education in ways that would facilitate catching up with the industrialized nations.

Besides, as Bishop (1990) notes, curriculum adaptation has not been free from the cultural biases of the original development model. This understanding appears to have eluded educators in Africa for a long time.

2.3 Dominant Perspectives of Science, Environment and Development

A science curriculum, when viewed in the context of environmental quality, can be a source of a great deal of controversy. A technocratic view usually focuses on role of science related to prediction, domination and control. This perspective tends to view development as the expansion of wealth and profits which invariably leads to environmental degradation. This raises interest in exploring alternative perspectives, including the indigenous tradition of nurturing the environment (Knudtson & Suzuki, 1992). Since the turn of the twentieth century, the traditional science disciplines such as biology, chemistry, earth science, physics have been fragmented into numerous research fields, each field having its own language, procedures, and theoretical framework. To some analysts like Bauer (1992), such frameworks have created a myth of what really never existed, namely the "scientific method." The result, notes Hurd (1994), is an increasing isolation of young people from forms of science and technology available in their own traditional cultures.

Traditional disciplines have also been hybridized into new fields like astrophysics, biophysics, geophysics, genetic engineering, laser chemistry, biochemistry, geochemistry, biotechnology, molecular biology. These interdisciplinary reconstitutions of science, forming what Hurd (1994) has called postmodern science, are thought to provide a broader context for research to deal with complex problems.

Among the examples of dilemmas created by socially useful advancements in science and technology are the ethical and moral issues raised by the organ transplants from other mammals into humans, the test tube babies, and the global pollution problems created by a nation or small group of nations but affecting the majority (Segerson, 1992). More such attributes of complex problems are observable in the research problems related to biotechnology, human behavior, and the interaction of human organisms with social and physical environments. Taken strictly from this perspective, the postmodern science defined by Hurd is not significantly different from modern science when it comes to fostering an understanding of the interdependence of people and the environmental systems and for educating about the environment. Furthermore, some of the most resilient environmental problems are now being caused by "scientific" tinkerings with molecular-genetic biology and biotechnology (Norgaard, 1994; Suzuki, 1994). Norgaard continues to point out that in the dominant perception of development, the result of unsustainability is seen as a lack of modern scientific knowledge and technological advancement to uncover new resources and solutions. Norgaard and other like-minded philosophers have reminded us of the need to challenge this kind of reasoning. In turn, we need to seek an understanding of the various perspectives and horizons which bear on science, teaching, and development in ways that will stem the attitudes from spilling over into the world of industry and trade.

An underpinning philosophy of this study is that the purpose of science and science education for the twenty first century should clearly be directed towards the development of responsible citizenship for dealing with scientific, cultural and technological problems related to the environment, energy, health, and agriculture. These concerns will require a holistic revisioning and teaching of science in a context that extends beyond the laboratory and the rigid boundaries of disciplines. The goal then should be a curriculum that can be lived and which has cultural, environmental and scientific focus and validity. The ultimate purpose of such a holistic science should be to foster the participation of students and various social groups and communities in the planning of the scientific and technological aspects of sociocultural and environmental future. In this way, the society of today could have the opportunity to step out of the shell of positivism. Positivism as embedded in "scientific" notions of development has become the accepted methodology for publicly addressing problems and values. As Doll (1993) has argued, potential shortcoming of this perspective in scientific and related discourse is that the subjective dimensions of every problem are downplayed. Under positivism, when all sides argue that they are only addressing the "facts", society loses its ability to speak to sociocultural and environmental values and to integrate them in their individual and collective decision-making (Capra, 1982; Norgaard, 1994). These scholars point out that what is needed is an approach which integrates sociocultural and environmental concerns and situates environment in education to capture the inherent problems associated with science, technology, society and the role of science education. By redressing the challenges and inconsistencies inherent in current science and science education discourse, such an approach would counteract the universalistic epistemology whose view of the reality of the natural world is indifferent to the personal qualities of the inquirers. This universalistic position which currently permeates the discourse of science and science education has been challenged by some philosophers of science, feminist scholars like Keller (1992); Keller & Longino (1996) and most recently by multicultural advocates, notably Hodson (1993), Stanley & Brickhouse (1994).

The poorest individuals and nations with the least flexibility and fewest options within the dominant market economy have been unable to overcome the turmoil sufficiently to find a development path which meets their basic needs (Apple, 1996; George, 1976). The difficulties of the poor have also been compounded by the environmental uncertainties caused by floods, droughts, agricultural pests and ethnic violence (Hicks, 1988; Toh & Cawagas, 1989). Thus rather than pursuing and blending into homogenous forms of development defined by a global market system, differences between nations and between people within nations have been accentuated. Neitschmann (1987) explains that the most "powerful" people in most of the developing nations have little control over their destinies. He notes that new technologies are determining the mindset of evolving social organizations that evolve as well as the kinds of organizations that must be designed to control and offset technological effects. Caught up in this trap, societies fail to engage in critical dialogue on alternative scientific discourse and appropriate technologies based on balance and sustainability values. Instead they yield to being shaped by the stampede of modern science and technology.

While traditional or modern science acknowledges that no mind can make all of the observations or comprehend all that is known, it assumes that this is simply due to the limited power of individual minds to observe and hold all of the knowledge from a multitude of fields (Ravetz, 1971).

With the future of humanity at stake, we need to dig out and diffuse the deep-rooted misunderstandings which have prevented the realization for the necessity for processes to coordinate separate knowledge. In particular, we need to think more about how disciplinary science, values, coordinating understanding, social structure and collective action fit together. In scientifically formed communities and discourse, however, when an issue calls for unusual knowledge, the need for experts is simply invoked. Ravetz continues to point out that a belief in the separateness of science and society compounds the problem of supporting research and using science for the common good of all peoples. The "objectivist" nature of modernism renders knowledge as a given, something which resides within individuals, particularly technocrats and experts who help frame the choices. When the technocrats need better information which cannot be obtained through the sharing of knowledge among technocrats, it is presumed that it can only be generated through research based on the scientific method. Yet for information to be useful for solving complex problems related to environmental issues, it must become more than separate parts.

The processes of dialogue and the sense of obligations associated with democracy -- including dialogues among scientists -- are not understood to contribute to the better knowledge necessary for informed decision-making.

Funtowicz and Ravetz (1990) have warned how the science of large scale environmental problems such as global climate change or nuclear waste disposal differs from conventional pure science. They contend that scientists cannot weigh various uncertainties at different stages of their analyses of such complex environmental problems to the satisfaction of the public. In their view, the public must and should participate in the analysis. Funtowicz and Ravetz affirm the concerns raised earlier that the increasing complexity of the problems arising from interactions of modern science, technology and society in "development" pursuits challenge the dominant collective understanding of reality. Central in current beliefs is the notion that material and wealth accumulation is infinite. To challenge this belief, it is necessary to have broader participation and fuller use of democratic processes in knowledge generation and validation.

2.4 Women, Nature and Culture in Science

The dominant image of a scientist most frequently projected by the curriculum is one of a self-assured, technologically powerful manipulator and controller (Hodson, 1993; Capra, 1982). Bacon's dictum that "nature yields her secrets under torture" (Capra, 1982, p.39) grossly goes against, for example, the perspective of Islamic scientists who stress the need for humility, respect for the subject studied and recognition of the limitations of science (Sardar, 1989). Bacon's unilateral view of science could also be seen within the feminist arena as an ancient association of woman and nature. Capra (1982) and Adams (1993) allude that the exploitation of nature has gone hand-in-hand with the exploitation of women, who historically have been identified with nature.

In many indigenous cultures, nature -- and especially the earth -- is seen as a kind of nurturing mother, but in some instances and locations it is also seen as a "wild" and "uncontrollable" female. With the rise of modern (also called Newtonian, or mechanistic/technocratic) science modeled after Bacon, nature became a mechanical system that could be manipulated and exploited, together with the manipulation and exploitation of women. Carolyn Merchant is succinct on this point:

> In investigating the roots of our current environmental dilemma and its connections to science, technology and the economy, we must re-examine the formation of the world view and a science which, by reconceptualizing reality as a machine rather than a living organism, sanctioned the domination of both nature and women. The contributions of such founding "fathers" of modern science as Francis Bacon, William Harvey, Rene Descartes, Thomas Hobbes and Isaac Newton must be re-evaluated (in Capra, 1982; p.41)

For some years now, women and other "minority" groups around the world have worked to transform the social order that sanctions human oppression and environmental abuse. Ecofeminism for example, identifies the twin domination of women and the rest of nature. When a patriarchal spirituality associates women, body and nature and then emphasizes transcending the body and transcending the rest of nature, it makes oppression sacred (Adams, 1993).

The logic of domination, according to which "superiority" justifies the subordination, is described by Warren thus:

> The sort of logic of domination used to justify the domination of humans by gender, racial, or ethnic, or class status is also used to justify the domination of nature... ecofeminists insist that naturalism is properly viewed as an integral part of any feminist movement to end its sexist oppression and the logic of oppression which conceptually grounds it. (Warren (1990) in Adams, 1993; 2)

This logic of domination is often expressed in dualities which represent a dichotomy rather than a continuity thus enacting exclusion rather than inclusion. Such dualities which characterize Eurocentric patriarchal culture can be traced to classical thought, Jewish and Christian religious traditions, modern (Newtonian) mechanistic science, and Enlightenment Philosophy, emphasizing autonomy and objective knowing (Adams, 1993; Capra, 1982).

The concept of "revisioning," as used in this study, is a pursuit or a means of *looking again* in order to correct or improve. In revisioning science towards a sociocultural perspective and concern for environmental sustainability, it becomes necessary to evaluate the existing sociocultural frameworks to determine whether they impede or foster eco-justice or environmental compassion, their sensitivity to any form of human classification, and consideration of how these traditions are detrimental or beneficial to the elimination of environmental exploitation, including that of women (Ezeife, 1994; Franklin, 1990).

Perspectives of how the incorporation of diverse cultural and religious traditions (including ecofeminism) are or can be addressed in a holistic science curriculum is an important and critical question which should be raised in order that views can be shared. During this study, the search for an understanding of the perceptions of scientists and science educators, policy-makers and indigenous peoples *man*, *nature* and *woman*, and the potential impact of these perspectives on policies, planning, and theories regarding women in the Ugandan context became critically important.

Kelly et al. (1993) point out that new voices in science studies need to offer much more than a better description and knowledge of science. They need to go further to promote a better science, de-mystifying the enterprise and rendering it more attentive to the needs of society. In this study, interest is directed at the level to which voices of the majorities are recognized and represented in science and science education programs in a university setting in Uganda. This inquiry also sought an understanding among the university scientists of their perceptions of science, particularly the environmental science, as contingent upon the social conditions that govern its construction, and how this should be established in university science and science education curricula. In addition, of interest to this inquiry was the degree to which the role of social consensus related to environmental concerns has been built into scientific discourse in Makerere University. It is this search for balance between the attentiveness to social concerns and what should constitute an environmentally meaningful and useful science curriculum that encourages scholars like Orr (1992; 1994) to urge scientists and educators to avoid the debilitating separation of abstract intellect and practical intelligence[7] in order to center science and its applications into wider social and ecological contexts.

Environmental problems and cultural conflicts have tended to arise because they cut across the areas of expertise of agricultural, forestry, fisheries, water and air quality agencies, on the one hand, and the traditional or cultural practices on the other. In conceptual pluralism, one finds the various definitions of development, or sustainable development, controversial and often limiting (Redclift, 1984; Orr, 1992; Fien, 1990; Hodson, 1993). Emphasis on social organization vis a vis technology without questioning the nature of science, which is critical to the conception and development of technologies in the first place, calls for an understanding of the perceptions of what sustainable development really is in settings like Uganda, what behaviors are deemed fit, and what the implications are for science and science education. These kinds of concerns were raised in this study to provide opportunities for accessing views which could stimulate a rethinking of the nature of environmentally and culturally relevant sustainable development and encourage the appropriate reorganization of science and science education.

Perceptions of science and its ability to inform politics has always been characterized as the scientific ability to predict. In this regard, Spragens (1981) mentions that scientists themselves also typically argue the need for a stronger base of knowledge generated through research and their aspirations for hiring more specialized scientists who can accurately predict the dynamics of complex systems. But does the increase in knowledge and in the number of scientists improve the predictive capacity of science? This raises curiosity as to whether there is an alternative theory or understanding of how science can serve the diverse nature of society justly for holistic and sustainable future interventions with the environment. Horton (1971) intimates that:

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[7] *Practical intelligence is used in Aldo Leopold's sense of teaching the student to "see the land, to understand what he sees, and enjoy what he sees" (Leopold, 1991: p. 302).*

> the quest for explanatory theory is basically the quest for unity underlying apparent diversity; for simplicity underlying apparent complexity; for order underlying apparent disorder; for regularity underlying apparent anomaly.
> (p. 209).

Horton's point challenges the positivist view that "things" of common sense are real, while those of theory are mere fictions useful in ordering the world of common sense. Such a stand-point reminiscent of dominant science, with its notions of knowledge of phenomena for the sake of knowledge and its emphasis on technique and efficiency, is not sufficiently inclusive of African humanistic, environmental and spiritual underpinnings (Asante, 1988).

Every culture has its own perspective of science which is a part of its total symbolic expression and is linked to its architecture, art, sculpture and even religion. Ezeabasili (1977) also informs us that traditional or indigenous science is an account of nature and how it works. He particularly alludes that the questions which concern scientists of a particular culture, the priority and the framing of these questions, and the methods of thought involved are all determined by the particular preoccupation of the people and the way in which the universe presents itself to their understanding. These understandings notwithstanding, modern science as it has been taught in schools and institutions of higher learning in Africa, has been from an exclusively technocratic and traditional male perspective (Ezeife, 1994). This teaching and learning have pursued an orientation which tends to exclude females and peoples of many of the world's cultures from effective science discourse (Hodson, 1993; Matthews & Smith, 1994). It is conceivable that science, as practiced by Africans or perceived by females and other cultures, may provide some answers and insights towards some underlying causes to the problems modern science is encountering, particularly in the area of environmental depredation. Molefi Asante, a proponent of Afrocentrism, states:

> Western science, with its notions of knowledge of phenomena for the sake of knowledge and its emphasis on technique and efficiency, is not deep enough for humanistic and spiritual viewpoint.
> (In Murfin, 1994: p. 97)

Many Western peoples as well as some African elite regard traditional African cultures as "primitive", while some Africans and an emergent community of scholars in the North also question aspects of modern culture, particularly as it relates to environmental quality and its implications to people's overall safety now and for the generations to come. While Africa is not monolithic in culture and involves a diversity of peoples, there are many overlaps and commonalties in language, traditions, beliefs, values, artifacts, and a linkage with mother nature which transcend tribal heterogeneity and/or national boundaries. Africa, like in other societies, has activities in the natural environment which call for critical understanding and explanation.

Appropriate recognition of the spirituality of forests, mountains and the water systems, for example, are important aspects of some cultural approaches to phenomena and events in the natural world (Capra, 1982; Toh, 1995). Concern with maintaining a harmonious relationship between people and the natural world is also noted as a key element in many African cultures (Asante, 1988). Modern science, with its emphasis on controlling and manipulating nature, and science education, with its emphasis on individuality and competition, appear to come in direct conflict with the fundamental African concern for "family" and "community" that are seen as governing all human and cosmic reality (Prophet, 1990).

These considerations inspired this study to inquire from the university academics whether they consider it meaningful to recognize a perspective of "African Science" -- a style of inquiry in which priorities, practices, and criteria of judgment are more likely in sympathy or commensurate with ecological settings, traditional values and beliefs.

Hodson (1993) points out that a sociocultural approach to holistic science and science education requires educators to explore and encourage other ways of research as a way of challenging dominant scientific and technological perspectives. Richardson (1994) is equally explicit on this point and expresses his reservations for granting science research processes which, he says, demand a "research design (which is) based on questions raised from literature (review)" (p. 318), thus resulting "in an interconnected network grounded in literature-based inference rather than questions and problems generated by local educators and circumstances." (p. 318). This advocacy for public ownership or democratization of the research process which Richardson asserts should be constitutive of an "educational research recoupled within local communities (which) can form the glue that unites the atomized students, teachers, parents and communities" (p.318).

The communities throughout Africa also have traditional thinkers (philosophers) who, through the years of inter-action in their communities and with the environment, have attempted to unfold truth (knowledge) or their reality in nature. According to Murfin (1994), the relative lack of visible scientific accomplishments, and appropriateness of African traditional forms of knowledge, their usefulness and meaning may be related to the humanistic nature of traditional African knowledge forms, including science. In recognizing that any given knowledge framework is better understood or results in answers which are more advantageous to some people than to others, this study was an effort to investigate these forms of knowledge with a view to unearth their value and relevance for environmental sustainability in Uganda. In this way, this study attempted to initiate an exploration for a conceptual pluralism which could promote participation of the marginalized majorities, and decentralization of knowledge generation and validation in formal schooling which has historically excluded indigenous knowledge.

In his writings about indigenous knowledge systems, Banpasirichote (1988) draws our attention to two levels of knowledge -- the ideological and practical. He points out that, at the ideological level, the interest in searching for an ideology of development focuses on a self-description of society which serve to provide a native's view of society. The practical level on the other hand relates to the technical forms of indigenous knowledge. What seems apparent is that these qualities and attributes of knowledge have not been carefully analyzed to identify and articulate how they capture development and environmental perspectives present among indigenous communities of most South nations like Uganda. The study took a step further towards identifying any such aspects of what Habermas terms critical-reflective forms of knowledge generation and dissemination. Indigenous science is intricately interwoven with other aspects like beliefs and myths within the system of indigenous knowledge. Therefore it is difficult to draw a line between culture and corresponding indigenous knowledge and science as they are all a part of each other. The notion of the holistic nature of indigenous knowledge raises an awareness that indigenous technical or scientific knowledge is often accompanied by some kind of knowledge of social organization and beliefs (Asante, 1988; Murfin, 1994). Most academic texts in science and other disciplines, however, tend to describe physical systems and activities as closed and independent systems which are ultimately manageable by human beings. In such descriptions, systems like water, air, soil, biodiversity and cultures, which are the underpinnings of the very life on this earth, are relegated to a position outside the dominant preoccupation of the modern "progressive" persons.

To thinkers like Suzuki (1992; 1994) and Orr (1992; 1994), however, there are things greater than material possessions or wealth. These scholars make reference to cultural and spiritual dimensions as equally useful, valuable systems which are very powerful particularly among indigenous cultures. Because of the intimate relationship between culture and indigenous knowledge, the investigation on the activities related to indigenous knowledge needs to be broader than the discovery of modern scientific, technological and or environmental knowledge and or concerns.

In a parallel analysis to mapping out holistic approaches to ecologically meaningful discourse in schooling, Fien (1990) draws our attention to three important and overlapping conceptions of environmental education: education *in* the environment, education *about* the environment, and education *for* the environment. Fien notes that education *in* the environment focuses on the increased awareness of aspects of the environment and uses opportunities for direct contact of learners with the environment to give reality, relevance and practical experience to learning. This approach to environmental education, notes Fien, fosters environmental awareness by linking learning to direct experiences in the environment and allowing learners to become captivated by the complexity and wonder of natural systems or immersed in the values conflict over particular environmental issues. Fien contrasts this with educating *about* the environment, pointing out the latter as seeking to translate "concerns" into appropriate behavior patterns and actions by getting learners to understand how natural systems work and the impact of human activities upon these systems. The framework of educating *about* environment therefore includes learning about the political, economic and socio-cultural factors as well as about ecological factors that influence decisions on how to most responsibly use and live in the environment. Fien continues to introduce what he convincingly argues as constituting the deeper level of ecologically responsible education as education *for* the environment. His analysis posits education *for* environment as one which aims to promote a willingness and ability to adopt lifestyles and skills that are compatible with the responsible use of environmental resources. Such a transformation in social and economic priorities is clearly fostered by Fien's perspective of environmental education. This inspires search for conceptual spaces about which attitudes of materialism, universalism or monocultures could undergo change in favor of social empathy, equity and ecological balance.

Contrary to the above visionarism, the natural sciences have tended to assume a position of unparalleled authority in the twentieth century intellectual life in most educational institutions. A revisioning of science still demands that the current assumed value-neutrality of science and technology be reassessed and redressed in both theory and practice. Writings of philosophers like Kuhn (1970) and Feyerabend (1991) express skepticism over the universalism of methods of scientific observation and its claims to value neutrality and content independence. These authors and an increasing number of feminist scholars like Keller (1992) point out how scientific methodology is never innocent but always and inevitably influenced by theoretical commitments.

Questions about the cognitive authority of science have become more pressing as feminist and environmental movements are implicating science-based technologies and science research in areas such as biotechnology in the continuing subordination of women and the degradation of the environment (Merchant 1980). Merchant and her contemporary feminist scholars are drawing new attention to earlier feminist concerns on barriers faced by aspiring women scientists in the past; these questions are about content and practice of science and technology, the forms of discourse that scientists have historically cultivated, and the goals that have traditionally been idealized in the natural sciences. An emerging thinking seeks to transform boundaries and discourse of science. Reflective writings by Raskin and Bernstein (1987) advance a view that scientific work is a project which needs to be humanized. They also caution on the dangers of separating any explanation of natural and social phenomena from meaning without acknowledging human attributes such as love, happiness, despair or hatred in science and technology discourse. In their view, such a separation will cause profound and debilitating human and ecological problems.

These ideas are also inspired by scholars like Schwartz and Oglivy (1979), Capra (1982), and Luhmann (1989) who argue that we should escape the philosophical premises of modernity. We need to begin to comprehend the complexity of knowledge and social systems through multiple patterns of explanation which will facilitate revisioning the future through intertextual understandings other than through rigid mechanical-industrial ones. Worster (1988), like other emerging environmental historians, has equally pointed out how people have transformed their environments through conquering and suppressing indigenous cultures. He points out that species that evolved in one ecosystem can affect another and technologies that evolved in one culture and ecosystem can affect other cultures and ecosystems. Worster also argues well that the adoption of modern technologies unmatched by new social institutions can negatively transform environments. This is the terrain of conceptual dialogue to be traversed in seeking new directions and the function of knowledge in educating *for* environment and survival of the majorities whose life depends on it.

This study sought an understanding among the university academics and the indigenous participants of their perceptions of the ecological and socio-cultural processes that underlie ecologically-sustainable and socially just ways of organizing and informing people-environment relationships. The intent of the inquiry was to gain an understanding of the perceptions of the university academics and indigenous people about the role education plays in the promotion of sustainable development, and how education programs for environment could best be planned and implemented. It was hoped that this understanding would lead to a discussion about the type of professional beliefs and practices which should be developed and encouraged among scientists and science educators to foster their contribution to socially critical objectives of environmental education.

Basing education for environment around such perspectives was perceived by this study as a strategy to provide opportunities for participation and collaboration among students and communities. It also created the opportunity for personal and professional growth by developing their critical understanding of environmental systems and management, evolving their skills for investigating, analyzing, interpreting, and solving environmental issues and problems, and availing opportunities to develop their understanding of nature, scope, purpose and processes of environmental education. Students contacted during the study were encouraged to share their views on how the application of these understandings in a critical and reflective way could contribute to planning and implementing a holistic postmodern science curriculum which incorporates sociocultural knowledge and awareness people's lives.

Holistic revisioning of science to incorporate environmental sustainability has drawn the attention of some researchers. Brennan (1986), in his advocacy for "a new kind of education based on a new definition of conservation and a new approach to teaching and learning about the environment" (1986:1), suggests conservation as a way of life and as a philosophy of living based on the natural and physical laws of science that is motivated by the moral, intellectual and social environment of the individual. To Brennan, such a program of education would involve all disciplines and all levels of education, be interdisciplinary in its approach, and conceptual in its structure. For Brennan's concept of education to be achieved, however, there must evolve a recognition by the people engaged in discourse about their interdependence with their environment and all life alongside cognition, valuing, and commitment to a responsibility to maintain an environment fit for life and fit for living.

Environmental destruction is generally faced by all communities in a world today at rates that may be unmatched in recorded history. This include destruction of forests, the creeping of barren lands over formerly productive crops, grasslands and forest, the increasing poverty of land and water systems, industrial pollution, effluents and process-solid waste disposal, abandoned mine-sites, reduced biodiversity, and deteriorating quality of human life due to decreasing quality, quantity and misallocation of resources. There is, therefore, a need for identification and implementation of a holistic science education which is a vehicle of empowerment -- a central platform of sociocultural and ecological science education as considered in this study. This requires that science education be much more overtly political in flavor, which also entails recognizing that environment is not just a "given" but a social and cultural construct.

2.5 Holistic Perspective of Science and Science Education

Adopting a holistic and sociocultural perspective of science means recognizing that many of those who suffer from scientific and technological change are the underprivileged members of society, which includes a disproportionately large number of ethnic "minority" groups like women. In a wider global context this also means recognizing that the material benefits of the industrialized nations are sometimes achieved at the expense of those living in the developing nations (Apple, 1996). What is sought is an awareness that science and technology tends to serve the interests of the dominant minority (the rich and powerful) in ways that are often prejudicial to the needs, interests and well-being of the poor and powerless, sometimes giving rise to further inequalities and injustices. According to Gill and Levidow (1987), economic exploitation is sustained not only by science and technology but also, albeit indirectly, by science education.

This motivated my study to discuss views of the university academics and of the indigenous people about the inclusion at appropriate points in the curricula of such topics as national and world food production the effect of Western demands for cash crops on third world economies and the impact of industrialized countries' demands for "raw" materials on the depletion of mineral resources and deforestation. Issues such as the ethics of linking economic, agricultural, and medical aid from the industrialized countries with the trade or military agreements, the ethics of "dumping" obsolete or banned substances such as pharmaceutical, agrochemical, technology, consumer or industrial products in third-world countries, the energy crisis, industrialization and pollution problems, waste disposal and waste utilization options and strategies. The interrelationships between rural-urban migration and environmental health concerns, poverty, and nutrition concerns were also raised during these discussions. It was crucial to determine how the science academics and the indigenous people view the destruction of rain forests in pursuit of financial gain and economic growth. How could a science curriculum create an awareness of the critical considerations for scientific and technological development which are intractably linked to questions of the distribution of wealth and power? Do they perceive the problems of environmental degradation being rooted in societal values? Reactions and reflections on these kinds of questions provided a leeway into the university academics' and the indigenous people's views of science, environment, technology transfer issues, and concerns for social responsibility.

According to Hodson (1993), environment is a social construct in the sense that "we act upon and change the natural environment and in the process construct and reconstruct it through our social actions" and because "we perceive it in a way that is dependent on the prevailing sociocultural framework" (p. 705). Knudtson and Suzuki (1992) also inform us that many indigenous people perceive environment in significantly different ways. Recognition of these socioculturally determined perceptions serves to highlight the need for educators, when assisting learners' understanding of the world, to be cognizant of whether they mean their world (the immediate world of the learner), *the* world (particular Western view of society, science, and the environment), or *THE* world in the sense that each learner is given access to alternative perceptions.

The goal of this study was to establish the perceptions, point of convergence and/or divergence, cognizance and utilization of these three meanings among the university academics and the indigenous people. Taking into account other cultural perspectives regarding the nature of scientific rationality was a key element for the holistic revisioning of science which could infuse sociocultural and ecological sustainability in the curriculum.

In his analysis of *the image of a physicist*, Brouwer (1993) points out that public distrust of the impact of new scientific discoveries on livelihood can be traced back to the Renaissance, when demands were made for alternative scientific engagements "in investigations that are more useful to humanity at large" (p.234). In the framework of this study, the alternative argument for revisioning of science draws, synthesizes, and argues from understandings of a coevolutionary way of understanding which has its roots in biology and results from the interplay of ecological and evolutionary processes. Ehrlich and Raven (1964) coined the term coevolution in realization of a species' environment consists largely of other species. As Charles Darwin, quoted in Futuyma and Slatkin (1983:3), noted "thus I can understand how a flower and a bee might slowly become, either simultaneously or one after the other, modified and adapted in the most perfect manner to each other," so to evolutionists who recognize the relations of ecosystems and ecologists who recognize evolutionary processes, everything is connected to everything else across species and through time.

From a sociocultural and historical perspective, the evolution of cultural diversity can be attributed to a time when cultures had more geographic space and there was infrequent contact or interaction among peoples from different societies. The technologies of war were less devastating and societies were less economically dependent on each other's resources, labor, and technology (Steward, 1977). However, at the current levels of population and economic interdependence, the challenge for sustainable development is to derive a viable image of the future, through sharing understanding of the benefits of diversity and a collective vision of the future as a coevolving system.

Within decades of joining the race for progress, the poorest of the poor in Africa have been forced to drop out or have been left on the wayside. Ethnic groups manipulated by local and external elites and forces have pitted themselves against each other in an attempt to control the remaining social order and natural resources (Redclift, 1984; Brown, 1995). Many of these poor countries are experiencing increasing difficulty in overcoming ethnic differences. National governments dedicated to a modernization development model continue to fall short of meeting the basic needs of their citizen-majorities. Instead they are chained to a poor adaptation of the modern story of progress which has disempowered people's creativity and initiative (George, 1976). Our vision for a richer image of progress through the construction and interaction of social and environmental spheres is desperately needed at this time of increasing social injustices and ecological crisis (Toh, 1995; Braddock, Fien & Rickson, 1994). Unfortunately that vision has been clouded by the image of progress through control which has conventionally been justified on the grounds of lack of an better alternative. The main threat to living with diversity comes from the habit of thinking in terms of such monocultures as modernity. Monocultures of the mind erase diversity from our perception, from discourse, and consequently from the world.

The disappearance of diversity is also the disappearance of alternatives, giving rise to the "There Is No Alternative" syndrome (Shiva, 1993). It becomes important to raise questions about the frequency in contemporary times that nature, technology, communities and entire civilizations have been totally uprooted on the grounds that there was no alternative. Do alternatives really exist, or are they simply denied or excluded? Shifting to diversity as a mode of thought and a context for action calls for openness to emergence of multiple choices. To scholars like Naess (1989) for example, diversity enriches the world while monocultures impoverish it. Naess also strongly regards diversity as offering humanity and nature a survival option and monocultures as threatening to life in all its richness. The above arguments on sustainability and diversity are all in favor of a coevolutionary imaging of social and environmental reality in science discourse. They capture the holistic mosaic of life's whole subsystems like human values, knowledge, social organization, and technology in an interdependent relation to the natural environment. Writing about coevolutionary or interdependent systems, Norgaard (1994) points out that each subsystem, among values, knowledge, social organization, technology, and the environment, is composed of different "types" of ways of valuing, knowing, organizing, and doing things. Similarly, the environmental subsystem consists of numerous and different types of species and other natural characteristics as well as relationships between them. Like Capra's systemic world view outlined earlier, the dominance or frequency of each type within each subsystem in Norgaard's coevolutionary framework of nature is explained by its fitness with respect to the types of things in the other things. The relative importance, frequency or distribution of types results from selection processes. The emphasis on coevolutionary processes does not deny the fact that people directly intervene in and change the characteristics of their environments. The coevolutionary perspective merely stresses the next step -- the way in which different states of the environment alter the selective pressure and hence the relative dominance of species and relationships between species thereafter (Norgaard, 1994). While the modern explanation of history links development to control over nature and to environmental interventions which necessarily reduce the "naturalness" of the environment, the coevolutionary explanation recognizes that many aspects of environmental systems are the result of human intervention over millennia. It emphasizes how nature is social by incorporating how people have put selective pressure on the biosphere. It also emphasizes how societies are natural. By comparing and analyzing these world views, the intent of this study was to demonstrate how the division between natural and unnatural is embedded in the dominant modern understanding of nature and development, and to stimulate a search for alternative frameworks of science that are consistent with reciprocal living with nature and plural cultures and their world views as Norgaard's and Capra's systemic world views.

Sponsel (1987) alludes that curriculum guides for environmental science and environmental education have continually neglected the cultural factor as well as other relevant components of the anthropological perspective. This reveals one of the reasons why environmental problems in technocratic-industrial societies are beginning to be now perceived as manifestations of what is referred to as a *continuous environmental crisis* -- a crisis of character and culture. Sponsel highlights the concept of *culture core* as those aspects of culture that are most immediately involved in the use of natural resources for the survival and maintenance of society. Varying with communities, Sponsel points out that the core could include aspects of technology, economy, social organization, politics, religion and other components of the culture. To some degree, most studies in cultural ecology deal with how a population responds at cultural level to hazards, stresses, or other environmental challenges; how a population procures, processes, distributes and consumes natural resources; and how it reproduces, regulates and distributes itself through time and space.

Cultural ecology reveals that, in essence, every culture is an answer to the perennial question of the relationship between culture and nature, including the niche of humans in their environment (Moran, 1982). So each society creates a cultural strategy to manage its population and resources as well as to cope with challenges -- including natural hazards --

in its environment. One of the contributions of this study is the documentation of indigenous peoples' views thereby extending the principle of cultural relativism to culture-environment relations. With this new understanding of cultural perspective on adaptation and environmental problems, the goal was to deepen and intensify these perspectives with a view to seeking their contribution to environmental sciences and environmental education.

Longino (1990), on the other hand, argues that objectivity should be reconceptualized to mean the attainment of claims through a social process. She identifies two types of values permeating science, namely constitutive and contextual values. She defines constitutive values of science as those which are science-specific and "are the source of the rules determining what constitutes acceptable scientific practice or scientific method" (p. 4). Contextual values are on the other hand identified as those of personal, social, and cultural commitment inherent in any given discourse. In her analysis, Longino rejects the strict empiricist, scientific and realist accounts of scientific theories, recognizing the political implications of opening up science and instead proposing a central method of "contextual empiricism" for achieving objectivity in science:

> The theory which is the product of the most inclusive scientific community is better, other things being equal, than that which is the product of the most exclusive. It is better not as measured against some independently accessible reality but better as measured against the cognitive needs of a genuinely democratic community. (Longino, 1990, p. 214)

Longino's point suggests that the problem of developing a new science is the problem of creating a new social and political reality. If science is a product of the culture that produces it, it would be problematic to assume that science can achieve conclusions independent of the larger social context in which it operates. The social conditions and political commitments of a society deeply influence or shape the questions and claims generated by science. Nor can science escape the influence of the political economy in which it operates.

Because sociocultural values fundamentally influence the processes, content, and application of scientific knowledge (Kelly et al., 1993), the study sought an understanding of how the university academics portray the social and historic context from which scientific knowledge, particularly environmental knowledge, emerges. It also incorporated the search for levels of convergence or divergence between epistemological framings, apparent among both the university academics, and the indigenous people who were participants in the study.

Sociologists of science support the intents of this study when they suggest that sociocultural concerns in science, particularly when they capture the environmental concerns are more than questions of pedagogy. They mirror social, economic, and political tensions in science. This theme is clearly sounded by Michael Apple (1992) when he writes:

> I oppose the idea that there should be one textual authority, one definitive set of "facts" that is divorced from its context of power relations. A "common culture"... requires not the stipulation and incorporation within textbooks lists and concepts that make us all "culturally literate," but *the creation of the conditions necessary for all people to participate in the creation and re-creation of meanings and values.* (p. 10, emphasis in original).

Apple's point easily extends from cultural literacy to scientific literacy as mutually inclusive forms in many respects, and as a situation relating to sociocultural knowledge and ecological (environmental) sustainability. The question of how and whether science, and environment as treated in science is, or should be, viewed as holistic and school-worthy knowledge was an important guiding quest in this study. The acknowledgment of science as a human activity, driven by the aspirations and values of the society that sustains it, legitimates the different approaches which communities might take to define and organize science differently to fit their aspirations and values. Clearly, different societies have different priorities for science and will therefore identify different environmental, technological and development problems for which Hodson (1993) points out different criteria of success are determined and are applicable. As a consequence, different investigative strategies and methods evolve, and it follows that different theories and scientific, environmental, and technological solutions emerge. In other words scientific, environmental, and technological knowledge are culturally determined and reflect the social, religious, political economic, and environmental circumstances that are lived and valued.

While there may be debate among educators and environmentalists about the rate at which a paradigm shift is occurring and the effectiveness of different strategies for social change (Arcury et al., 1986), there can be no doubt that education has an important role to play in the transformation of values and the empowerment of individuals and groups, including women, and to encourage participation in environmental improvement and protection. However, environmental education takes many forms and there is much debate over the relative importance of different forms of knowledge, skills and affective objectives and the social and political interests served by the different approaches that arise from different emphases in objectives (Robottom, 1987).

In a similar vein, a number of authors also regard science as being principally concerned with one kind of object or event in terms of which everything else can be explained. This has motivated atomism/monism in their guises over the years alluded to by Brennan (1990), it is also the motivation in the "positivist" search for a unified science. Few scientists would want to make the objectivity of science dependent upon a single set of objects/events, or a single theory of them which explains everything. Moral pluralism, in contrast to monism, allows that the business of living decently and holistically involves many kinds of principles and various sorts of responsibilities. It recognizes that our feelings and responses to situations arising from interventions with the environmental system are informed and adjudicated from many sources in other subsystems and cannot be simplified without distortion. It maintains that the absence of any clearly articulated principles for a given case is no evidence of the absence of moral significance.

It is often the poor majority in the developing countries who are the losers and who are most affected in the process of environmental depredation, whether this process is initiated by large-scale capital or whether they themselves act as the agents of resource depletion (Redclift, 1984). So our visions of the future are closely linked to our understandings of the process and should run deeper than our ability to envision and aspire to an alternative future. In this respect, democratic societies should go beyond political considerations and extend towards the establishment of procedures through which we can give weight to the many complexities of environmental problems.

The challenge is to break through the atomistic and mechanistic views of Newtonian traditional science to incorporate newer understandings of systems uncovered by modern science and new philosophical thinking which leaves people and their ideas in those systems. We need to abandon the hope of finding a few universal truths, and accepting our own history in the unfolding of reality.

Understanding and knowing as a social process raises questions about who should participate in these processes of knowledge generation and validation. Ideally, under the epistemological and metaphysical tenets of modernity, a democratic society would consist of equally minded, broadly and highly educated people, each fully qualified to understand all dimensions of every complex issue. This myth has been perpetuated in part because it reduces the conflict between elitism and the popular participation associated with modern democratic ideals. Funtowicz and Ravetz (1990) explain that these pragmatic escapes, however, have hidden more than resolved the tension between the current use of science in the policy process and democracy.

This study was led to pose the question of whether collective understanding could be more effectively achieved under some other combination of structures, procedures, and forms of knowledge different from those of the dominant forms. Development has been largely been framed in terms of technical possibilities and economic efficiency (Apple, 1996; Norgaard, 1994). But serious concern for the environment and sustainable development for women and traditional peoples, for cultural diversity through the incorporation of traditional knowledge and for civil rights and justice, have been forced upon the international development agencies, their national counterparts, and their epistemic communities by non-governmental organizations. With a view to sustainability and on how knowledge forms such as the formal science curricula in schools are commensurate with the survival needs of the majority, it becomes important to investigate how these approaches and involvements cater to the environmental and developmental needs of the local communities. Unfortunately, much of the discussion on *sustainable development* (and of *sustainability of the environment*) have tended to focus almost exclusively on the contributions of the natural resources endowments and the maintenance of natural resource assets and their contribution to the well being of human populations (Norgaard, 1994). This exclusive emphasis tends to over-shadow the need to recognize the range of interrelated and interdependent factors which contribute to development - factors like traditional values, indigenous knowledge and practices, including indigenous technologies.

As the World Commission on Environment and Development (WCED) (1987) notes, certain dimensions of sustainable development may on occasion be in conflict with one another. A challenge which environmental education faces lies in the identification a framework within these competing goals. How can these goals be compared and to what extent can they be reconciled?

Democracy conveys the ideal of political equality, the vision of open public debate and sharing of knowledge, and the understanding that each person is obligated to stay informed of public issues in order to participate in public decision-making. It also connotes the understanding that the sharing of knowledge can combine to more than the sum of parts (Norgaard, 1994). While all of these ideals need strengthening in practice, the association of democracy with collective knowing needs elaboration as an ideal. With this strengthening, democracy has even more implications for structuring and sustaining communities. The way in which scientists coordinate their separate understandings determines the collective understanding reached. Science as a social process needs to be and can therefore be restructured in a variety of ways.

In this respect, Brennan (1990) also observes that, if there are any regularities in natural processes and systems, there is hope that modern sciences at least approximate some of these. It is thus important to determine in what ways notions of science and its extolled practices relate to the regularities in the natural and social processes in the environmental system.

The rationale for this study also gains support from Robottom (1985), when he points out that countries need to conduct research concerning the epistemological and institutional structures that affect consideration of environmental demands as well as the epistemological, cultural or social obstacles restricting access to, and their utilization of educational messages. Such inquiries are important and are bound to be informing because students' understanding of the nature of knowledge and the learning strategies that they consequently employ evolve through their schooling (Roth and Roychoudhury, 1994), and because the way in which knowledge is packaged and presented over the years of schooling is likely to affect students' understanding of and their relationship to knowledge.

If science is presented to students as a body of knowledge, proven facts, and absolute truths, then students will focus on memorizing facts and think that all knowledge can be ascertained through specific verification procedures embedded in the scientific method. If, on the other hand, students experience science as a continuous process of concept development, an interpretive effort to determine the meaning of data, and a process of negotiating these meanings among individuals, communities, and how meaning and practice relate to life, then the students might focus on the concepts and their variations in relation to experiences and contexts. In addition, the actual content and the types of competencies sought within each subject contribute to student perceptions of that subject as do achievement, competence, sense of efficacy, and learning strategies. The classroom is thus a dynamic conceptual mosaic involving the various and interacting social and cultural meanings exemplified by students and teacher. The possibility of meaningful learning thus rests on the assumption that students' world views are commensurate with those of science as it is taught.

Since environmental education has traditionally been effective in teaching about generalized ecological processes and environmental hazards, an education program that infuses aspects of environment in science is likely to be effective in promoting environmental understanding, social and environmental values, and action among scientists and science educators (Lutts, 1985). In this regard, Schleicher (1989) points out the need for a new ecological ethic which would give rise to fundamental changes in human attitudes and actions towards humanity and the environment. The scope of such a change in social values has been likened by scholars such as Fien (1990), Capra (1982), Toh and Floresca-Cawagas (1989) and Arcury et al. (1986) to a change in social paradigms or world views. These scholars argue that socially and ecologically sustainable people-environment relationships will result only when the "dominant social paradigm" of the twentieth century industrial societies, which tend to view nature as subservient to human needs and economic growth, is replaced by a "new environmental paradigm" which views people and nature as interdependent. Social values and attitudes of the new environmental paradigm include a high valuation of nature, respect for natural and social limits for growth, and a sense of empathy with other species and other people, particularly women, children, and the rural and urban poor. It also takes into consideration future generations, support for careful planning in order to minimize threats to nature and the quality of life, and desire for change in the way most societies conduct their economic and political affairs (Milbriath, 1984; 1989; Toh, 1987).

The scholarly insights provided in the sections above form a basis of this inquiry. In sum, education should seek a critical understanding of science's view of the world, and how this relates and affects various social and cultural groups and the environment. In an age when science and technology are driving rapid cultural and physical changes on Earth, it is imperative that these two forms of discourse contribute to richer understandings of perspectives in identifying goals and pathways which are consistent with the increasing concerns for sustainability, equity and justice to nature and various peoples. The centrality of science in people's lives now and in generations to come demands that its applications be interrogated in wider contexts than by scientists alone. In a time of rapid change, powerful technologies arising from advancements in science raise a need to give spaces for the voices of heretofore marginalized groups in having a say about what shapes their future.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Scope, Conceptualization and Rationale of the Study

The exploration which this study embodies sought to make a contribution to critical analysis and theorizing in science, technology, society and environmental (STSE) education. The study uses as its starting point an inquiry into dominantly held views, perceptions and assumptions about the nature of science, and of the promises of its technological applications for national development. The 'expert' models of science and technology were investigated to expose their technicist, patriarchal and capitalist foundations and the way these, in turn, contribute to cultural alienation and ecological decline. Some of the insights arose from personal reflections on my interactions and role as a scientist (physicist) and science educator at Makerere University in Uganda where I have worked within a context that seeks national development through teaching and applications of western models of science and technology for economic growth. This inquiry explored the paradox that such an approach to education and development has produced by not promoting social, cultural or ecological well-being. Thus the study is conceptualized and developed as an analysis of worldviews underlying western models of science, science education and technological applications and an empirical analysis of the views of two groups of people in Uganda - scientists and educators from Makerere University and traditional elders from the Osukuru community in Tororo District in Uganda.

This study sought to identify the sociocultural premises that might underlie an ecologically and socially sustainable approach to development informed by models of science and technological discourse that could contribute to the concerns for social equity, justice and sustainability alongside ecological balance. Guided by these perspectives and concerns the study sought to make a contribution to both science reconstruction, policy-making and to the considerations of the relationship education and development, especially within the context of South nations. This way, the study initiated dialogue between scientists and traditional elders -- a process that promises to sponsor and forge a vision of an *ecoscience* for sustainable development. The resultant theorizing provides a rationale for further explorations for all nations that wish to see education, in particular science and technological discourse, as a significant strategy for enhancing the quality of life and of the natural environment, rather than as a technical tool for economic growth.

3.1 Case Study and Qualitative Research Methodology: an Overview

In order for the study to comprehensively capture and relate the interdisciplinary themes it embodies, a case study approach embodying qualitative methodology as outlined below was pursued. Case studies have the potential to help us look at particular situations so that solutions for more general situations can be hypothesized and developed. To authors like Nieto (1992) and Hamel et al. (1993), a case study approach within a qualitative framework involves an intensive and holistic descriptive analysis of bounded phenomena, events, process or cultural reality. The use of a case study approach therefore accords the inquiry a deeper understanding of specific issues and problems contextual to the social, cultural, educational and or institutional setting. The case study approach used in this study employed a range of procedures and techniques within qualitative methodology namely, interviews, focus group discussions, a participatory workshop and some document analysis. As a means to access participants' views on the questions raised in this inquiry, I made an informed choice to use a case study within a qualitative - rather than quantitative - research methodological framework due to a number of reasons. First being that qualitative methods which include a wide range of techniques like interviews, focus group discussions, participant observation narratives, and participatory action research allow the researcher to access first-hand knowledge of the social realities involved (Maguire, 1987; Weiler, 1995).

The quantitative approaches to data gathering focus on observable and/ or measurable facts in the interest of objectivity and in the process tend to exclude important aspects of data such as human feelings, cares, and aspirations among populations being studied (Rahnema, 1988; Tandon, 1981; Maguire, 1987). In contrast, the qualitative approach adopted in this study is one that scholars like Tandon (1981) also call *social investigation* in the sense that it acknowledges and reclaims the humanness or the subjective dimension of the lives of participants in the research as people instead of subjects, and identifies them as both researchers and experts in their own context (Wolcoff, 1990; Tandon, 1988). In this approach, individual participants are considered active agents who define the nature of reality for themselves and the meanings that it generates through various interactions with their milieu (Filstead, 1979). According to Blumer (1969), the meanings that arise from social interaction accorded by qualitative research are modified and articulated through an interactive process. Maguire (1987) elaborates on the interactive potentials of qualitative research noting that these emerge simultaneously within the dynamics of negotiation and interpretation, often according researcher opportunity to engage in the dialogue. The qualitative research approach which I pursued therefore placed me in a dual role of an inquirer as well as participant; this role was unlike a quantitative survey in which I would assume an elevated and hierarchical stance of researcher. Qualitative research enshroud a *naturalistic paradigm* because it captures humanistic, nonpositivist, ethnographic, phenomenological[8] and hermeneutic[9] perspectives of knowledge production (Wolcoff, 1990). An appeal of the qualitative approach in the inquiry of this study lay in its potential for inspiration, naturalness and connectedness with the participants. My role as a participant in the study not only provided me with a cordial environment but also conveyed a perception of me as one who, and genuinely so, hungered for information. This allowed me to interpret and understand what my own beliefs or conceptions were about the study and issues arising out of the discussions. According to Robottom (1985) there is a tendency to emphasize eclectic teaching approaches, empirical testing and research. This, he explains, is pursued through recourse to observation and experience but with an emphasis on objectification of knowledge of the existing reality generated through sterile processes and expressed in value-free language. Due to the objective nature of modern science, common methodological approaches used to research science, technology and the environment have tended to be quantitative, seeking to isolate and relate specific effects to particular events in ways which tend to exclude some aspects of people's lives like beliefs and values. To scholars like Wolcoff (1990), this often leads to descriptive expositions which are lacking a philosophical and/ or theoretical interpretation and synthesis (Maguire, 1987). Critics of qualitative methods charge that such value-laden approaches are lacking in internal validity and empiricism, and the difficulty of replication and generalizability trivializes their conclusions (Borman et al., 1986). According to Borman and his colleagues, this denunciation of qualitative methodology springs from the positivist school which insists on independent verification of results (replication) through repeated experimentation and observation, asserting that such an independent verification must take place if knowledge is to be accumulated and theory advanced. As a school of thought, therefore, positivism recognizes only *objective* facts and observable phenomena and is disinterested in the causes or ultimate origin of these facts (Tandon, 1981; Fielding & Fielding, 1987).

In placing an emphasis in quantifying the behavior of human beings, quantitative research methodology is seen by scholars like Tandon, Wolcoff and Maguire as neglecting the crucial aspects of life that cannot be easily measured; and they challenge its assumption that there is a social world which exists independent of people's subjective awareness of it. On the other hand, proponents of qualitative research approaches counter-charge quantitative research as bearing little correspondence between its measurements and "reality". Krenz and Sax (1986), for example, reiterate that quantitative methodology has produced little "truth" that is useful or replicable in educational practice. Sax and Krenz also draw our attention to the fact that there is an increasing recognition for more scholarly and in-depth investigations which capture an understanding and explication of processes. This is an aspect that quantitative research approaches tend to omit due to over-reliance on instruments for standardized measurement and statistical analysis. The validity of theoretical outcomes in qualitative research is derived from operational definitions or measures across the studies (Wolcoff, 1990; Denzin, 1989). These authors also point out that validity of quantitative studies are mainly based on their comparability with similar studies. In contrast, they argue that in qualitative studies the question of validity is less rigidly defined. Elaborating on the question of validity on the perspective of qualitative research, Erickson (1977) convincingly underscores its powers to facilitate description of key incidents in functionally relevant descriptive terms in relation to the wider social context surrounding the incident or experience. This observation by Erickson affirms the strength of qualitative research methodology to yield knowledge validation and insights about people's lived realities to provide access to ample information and spaces upon which the construction of social realities rest. The openness to personal experience and interpretation which is acknowledged and valued in most qualitative inquiries -- when combined with increased attention to multi-method approaches as a means to triangulation -- enhances the chances for replication (Fielding & Fielding, 1987; van Manen, 1990).

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[8] *Phenomenology is a process of understanding of human consciousness and of phenomena in light of human interpretation of reality. Under phenomenology, no necessity is placed on formulation of universal rules since human beings are considered unique individuals. But, as Simmons (1993) notes, it integrates subject and object - with man and nature forming a continuous whole.*

[9] *Hermeneutics extends the notion of experience beyond the merely personal. Under hermeneutics the individual, the community and culture constitute a terrain about which meaning is constructed.*

The interest of this study was to establish the perceptions and areas of convergence and/ or divergence, of the worldviews reminiscent among the university academics and the indigenous people's settings. In this study, my search for perspectives among indigenous elders and from the formally educated class regarding possible ways of refocusing science for sociocultural and ecological sustainability demanded a methodology open to pluralism of approach, thought and philosophy. The advantages of qualitative approaches over quantitative methods as elucidated above made the former a candidate procedure pursued in this inquiry. This did not make the study simpler, for it is widely acknowledged that problems of definition and procedure plague data collection (Wolcoff, 1990). This problem of definitions is noted by some scholars as more compounded in quantitative studies due to underlying assumptions guiding the construction of definitions, scales, inventories, codings, editing, tabulations and indexes which tend to be biased against the marginalized (Tandon, 1988; Rahnema, 1990). As a consequence, quantitative data is not only conditioned by the questions asked, but also by the often rigid, pre-coded and, at times, gender-biased choices of responses which are offered to respondents (United Nations, 1980; Miers, 1983). For Tan (1988), qualitative research directed at the experiences of people potentially leads to a construction and reconstruction of meanings and experiences. Methodological approaches which seek facts observed and measured from a distance, treating people as objects incapable of investigating their own social reality have been critiqued on the basis that they promote a notion of reality independent from the observer, time, space, moral commitments, as well as the simplistic cause-effect picture of otherwise complex issues facing humanity. To Freire (1970), it is such simplistic treatment of critical social issues which contributes to people's alienation from their own decision making capabilities. In my view in this study is thus based on a social research due to its potential to acknowledge the lived experiences of participants as knowledge. This, as Maguire (1987) equally affirms, removes the traditional separation between knowing and doing and opens spaces for sharing the creation of knowledge for social transformation.

Some scholars have also proposed that qualitative inquiries can contribute to understandings, reframing of curriculum, and transformation of pedagogical practice. For example, Ayers (1990) intimates the potential qualitative inquiries have in challenging educators to explore more about perspectives and milieus which fashion lives of learners. He particularly believes that participation of policy-makers in qualitative research could create spaces for serious reflection on issues that relate to social issues and role of education. Max van Manen (1990: 154) extends this argument with a strong view that:

> hermeneutic and phenomenological reflection deepens thought and therefore radicalizes thinking and the acting that follows from it. All serious and original thinking is ultimately revolutionary...in a broader than political sense. And so to become more thoughtfully or attentively aware of aspects of human life which hitherto were merely glossed over or taken-for-granted will more likely bring us to the edge of speaking up, speaking out, or decisively acting in social situations that ask for action.

The qualitative methodology pursued in this exploration had thus its justification due to the opportunities it accorded participants to uncover and/ or examine their own assumptions about science about science, science education, development pursuits and how these discourses interact in shaping environmental quality. The qualitative approach thus also lent itself as a methodology for transmitting richness and complexity of social, cultural and ecological phenomena.

3.2 Geographical Setting of the Study

The study was conducted in two research settings in Uganda, namely Makerere University and Osukuru Parish in the Tororo District. Makerere University, located in the capital city of Kampala, has been the major and most well-established university in the country since its inception in 1922. Most Ugandan professionals and those from the surrounding African regions obtained their education at this institution. Makerere University has, among others, independent education and science faculties. While science students study exclusively within the Faculty of Science, science education students take their respective courses from both faculties. The choice of Makerere University for this study was motivated not only by its academic reputation as an institution of higher learning but also because of the active participation, over the years, of many of its academics in national policy panels in various sectors as well as consultancies related to science, environment, education and development. Such a rich background of diverse experiences provided this study with informed participants.

Osukuru Parish, near the Eastern city of Tororo, is a rural community in which the indigenous people, like in many locations in Uganda, are peasant farmers engaged mainly in traditional agriculture such as gardening and raising domesticated animals and birds. Traditionally each family maintains ownership of a recognized piece of land and all the resources in it. There are also mutually shared land resources such as a swamp and the River Malaba which provide households with water, grazing land for their animals, as well as a fishing and hunting ground. The neighboring Tororo city is both a commercial and an industrial center in which one of the largest phosphate fertilizer factories in the Eastern and Central African region, as well as a large cement industry was built. These industries were strategically located to take advantage of the large deposits of phosphate and lime in the surrounding hills in the location (please refer to Appendix A3). The industrial diversity of Tororo as well as the researcher's knowledge and experiences in the Osukuru Parish region made it a suitable setting for this study's research on indigenous perspectives on environment, development and the role of indigenous knowledge.

In an effort to gain insights into the understandings and perceptions of the Makerere academics and the Tororo indigenous people on the role of science, the researcher played the role of participant-observer. In addition, a study of documentary sources and observable behaviors was also conducted with both participant groups to establish related thinking reflected in the daily affairs of the two representative worldviews. These observations and other supplementary information was evaluated and synthesized to identify areas of their potential in contributing to a holistic framework of revisioning science. This outcome served as a basis for assessing consensus about the status and role of science in relation to people-environment interactions; and, when or where necessary, it established a basis for identifying ways and strategies for the re-evaluation of the university science and science education curricula.

3.3 Informant - Participant Selection

A purposive sampling procedure was used in selecting participants for the study. The selection criteria included a range of disciplinary specializations or fields in the case of academics. Also used as a criteria was diversity, and a balance between senior administrators, teachers, students in the university setting; government officers in departments related to environment, science, technology or education, and school teachers of science subjects. Among the participants chosen were the former Dean of Science, six professors, one department head (departmental chair), four senior lecturers drawn from the departments of Physics, Chemistry, Biological Sciences, Science and Technical Education, Educational Foundations and Management, and the Institute of Environment. A total of ten university academics one of whom was female, three government officers, three university students, four high school science teachers and two Tororo District officials were contacted and each made a useful contribution to the inquiry. Through a stroke of luck, I was also able to seek and obtain a privilege to chat with one of the coordinators of a donor program to Makerere University science and science education programs during his official visit which coincided with this study. I got his permission to share his views in this report as illustrated in the upcoming chapters.

In the Osukuru setting, being an elder was qualified by one's being at least 50 years of age. Six indigenous rural elders (of whom three were women) of Tororo were selected on the basis of their ability to converse in the cultural milieu, their accumulated experience in living in the area, their storyteller ability, and certainly their willingness to participate in the study. These important characteristics made their contribution to the study informative and credible. Initial contact with an selection of the rural elders was facilitated in collaboration an old friend of mine indigenous and resident in Osukuru with whom I had informed about my study intentions and interests before departure from Edmonton, Alberta, Canada.

Other informants for the study included science education instructors from the Institute of Teacher Education in Kyambogo; a science specialist from the National Curriculum Development Center; and government officers responsible for environmental policy, education, culture and community development. The input from this group of informants was sought to complement the contributions of participants from Makerere and Osukuru.

3.4 Data Collection Processes

A qualitative inquiry which embodied three main methods -- focus group discussions, informal guided interviews, and a workshop - was employed to facilitate the smoothest possible access to the complexities of lived experiences and views of people. My data collection at Osukuru [illegible] conducted using the three approaches, namely focus group discussions, interviews and a joint workshop involving the university academics. Two focus group discussions were held in Osukuru, involving five participants: three men, two women both aged over 50 years, and myself. I was able to follow-up on the workshops with a total of eight interviews, with at least one interview for each of the participants. I made arrangements to have a separate focus group discussion for women in which I was assisted by a female research assistant. Her presence helped to make the women more at ease during the discussions. Two focus group discussions for the women in Osukuru were held, alongside a couple of individual interviews with each respondent.

Due to the pressure of work in the Makerere University setting, there was a preference for personal interviews; therefore, focus group discussions could not be arranged with the faculty or student participants.

The use of focus groups, individual interviews (which entailed multiple visits for most participants) and a participatory action research involving a joint workshop for participants availed this study the opportunities to cross-check information. These three methodological approaches were complemented by document analysis. This combination of methods enabled me to gain deeper insights into the various spheres of participants' awareness by examining how they have woven together the different facets of their lives. This methodological approach also provided the researcher and participants with a rich synthesis which combined sociocultural understandings with the tradition of qualitative research. While most of the interviews, discussions and workshop were tape-recorded and later transcribed, no form of recording could capture the entire conversation. The final representation of transcripts in the form of written text made the transcription incomplete, partial and selective. This is because, while the tape recording can capture the sound of language, the speech dynamics -- the pauses, inflection, emphasis, the unfinished sentences, and laughter -- are impossible to recapture and re-represent in their entirety. So transcribed texts miss out on the subtle range of emotions inherent in such dynamic vocal, body and facial expressions. The transformation of spoken language to written text and subsequent editing of other critical aspects of the conversations portrays lack of transparency of language. While honest reporting has been adhered to in all narratives and responses given in this report, such intensity of non-verbal communication cannot be wholly represented.

The research began with a study with and by the indigenous people living in Tororo, which involved an examination of their values, practices, attitudes, and views in relation to their traditional (cultural) and contemporary ecological perspective: their interventions in and with the environmental system. This study was interested in discussing and observing with a view to identifying how the indigenous people in Tororo interacted with their environment; which knowledge forms, technologies, values and social organizations were involved; and the extent to which science, as embodied in the curricula, has been incorporated or could potentially support these development activities. Interactions, observations, and informal interviews with the indigenous people in Osukuru (Tororo) revealed their cultural beliefs, artifacts, and inherent knowledge in relation to their harmony with people and the natural environment.

The inquiry process probed the appropriate cultural domains in order to "tease out" the subtle patterns and meanings of physical activities in the elders' interventions with the environment system. Discussion of the aspects of traditional forms which fit an interdependence relationship with the environmental system, and the extent to which the university science and science education curricula have evolved, and concomitant technological innovations that spawn responsibility to the ecosphere were of particular interest to the study. Through focus group discussions, informal guided interviews and workshops, and some complementary document analysis, the study brought to the surface an understanding of how scientific knowledge and discourse could be revisited to provide new insights and concepts to mold people's perceptions and actions to foster harmonious people-environment interaction.

Each individual's unique combination of interpersonal variables represented a certain behavioral disposition that predisposed that person to certain modes of behavior in group (Stewart & Shamdasani, 1990). This behavioral disposition is identified by Stewart and Shamdasani as interdependently determining group-members' responses to each other. To optimize focus group participation in this inquiry, therefore, a concerted effort was made to carefully cater to differences in individual personalities to ensure group cohesiveness (Stewart & Shamdasani, 1990). Withdrawal of views, apathy, shyness, including emotional outbursts arising from paradigm and other social status disparities, did not arise during this study.

3.4.1 Focus Group Discussions and Joint Workshop

Central to the approach of focus group discussion was the need to develop a rapport with participants and their world in order to gain an insider's view. Focus group discussions emphasizing interaction and group dynamics not only accorded a given participant group the opportunity to share and reflect on their individual situations both singularly and within their unique social context, they also helped the study obtain more diverse data and prevented simplistic generalizations. These group discussions also provided insights that permitted reflection on many of the basic assumptions about environment, science, university academics, indigenous people, women, and possible routes to change.

Two focus groups of four to six participants, one mixed group and the second consisting only of women, were established in each research setting. There were two mixed focus group discussions in Tororo, followed by a single focus group meeting with the women's group. Because of a sensitivity to some women's concerns and experiences which might not be easily revealed to a male researcher, I felt it was prudent to orient a woman research assistant to run the indigenous women's focus group discussions at Osukuru Parish, Tororo. The assistant was identified from among the female teachers at Tororo Girls School in the neighborhood of Osukuru Parish and was herself indigenous to Osukuru Parish. She was contacted and her consent and that of the school administration was sought in writing. She was then briefed by the researcher on the background and interests of the study. Research questions were elaborated upon and broken down into forms that could be asked during the indigenous women's focus group discussions in order to direct the responses towards their individual experiences, concerns, and aspirations. This research assistant was also invited to act as a participant in the initial mixed workshops in Osukuru Parish to provide her with an orientation to and a grasp of the research interests. As a geography teacher who had a profound interest in fieldwork, her active engagement in various community-based studies in other projects made her an invaluable research assistant and participant. A joint workshop held at the end of the data collection facilitated the triangulation and social validation of information collected. The university academics traveled to Tororo for the workshop, which was designed to promote dialogue among the participants based on the principles of participatory action research[10], namely collaborative engagement of participants in systematic self-critical reflection. The interactive dynamics which the workshop fostered gave it a different tempo of participation in comparison to the focus group. Structurally, a useful arrangement I used was a circular seating form. During the joint workshop, we sat around tables set in circular mode; the tables provided the participants a place to rest their hands, write notes and place their snacks. To stimulate discussion, I encouraged each member to introduce him or herself through narration by giving a brief personal history. These narratives were a good "ice-breaker" and generated interest in discussions of the environment and development. A number of participants had previous exposure to the nature of my study from encounters at the focus group or interview discussions. Following participants' self-introductions and mention of their interests and or involvements on issues related to the environment, I launched the workshop through a brief overview of the study's research question and an invitation to the participants to raise questions surrounding their experiences and concerns on environmental quality, social harmony and the challenge to science and science education. There was a spontaneous response in which the following set of questions was fielded: *1) What is it that ~~we~~ now love instead of nature, people, and their survival? What has eroded this love? 2) How does the school curriculum promote love for the people and the environment? On what foundations does this curriculum rest? 3) What aspects of policy affect environment? Who participate and influence these policies? 4) In order to make education socially and ecologically responsive, what role should science play? What values, attitudes and practices should science foster? What are the constraints? What strategies are required to reverse the trend to back to nature and to people?*

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[10] *Carr & Kemmis (1986) point out three conditions necessary and sufficient to realize action research: 1) a project which takes as its subject matter a social practice/participation; 2) the procession of the project through a spiral of cycles of planning, acting, observing and reflecting; and 3) the involvement of those responsible for practice in of the moments of the activity, widening participation gradually to include others affected by the practice, and maintaining collaborative control of the process. In this study, collaborative participation was limited to reflection and, to a limited extent, planning. There are intentions to engage in the full cycle of the action research later on as a means to realize the envisioned transformations.*

During the ensuing response and discussion over these questions the participants engaged in a process of self-reflection in relation to their own theory (guiding assumptions) and practice, in relation to themselves as increasingly conscious professionals and/ or transformative actors, and of the contexts in which they operate. Throughout the process, there was room for me to steer participants' views to the focus of the study question. The participatory nature of the workshop was critical in predisposing participants toward an ideology-critique that led to the recognition and negation of those educational ideologies which have served the interests of specific groups at the expense of others. As Carr and Kemmis (1986) point out, the interests of action research are emancipatory in the sense that they aim for the liberation of participants from the mystification of ideology, the dictates of habit and precedent, and the compulsions of self-interested authorities. And according to the Cambridge Journal of Education (1990), such occasions for deep reflection are paths to self-understanding and professional development and sponsor search for self-knowledge through discovery, reflection and reappraisal.

Although questions and hypotheses for the respective focus group discussions arose "in situ", my perspective was guided by the following issues:

Issue 1 How do indigenous people view formal education, in particular, scientific knowledge vis a vis their traditional ways of relating to people and the environmental system?

Issue 2 How do the indigenous rural people carry out development-related activities, and with what regard for the environment? How do they pass on their knowledge and skills? How has formal science knowledge in school bolstered traditional people's capacity to cope with the deteriorating nature of the environment? In what ways, if any, has their relationship with the environmental system changed as a result of the mainstream development agenda pushed by the state? How are these changes viewed, explained and interpreted? What differences and similarities exist between groups in the indigenous setting? What are the implications of these views to science and science education in terms of the curriculum and pedagogical practice in the university and school system?

Issue 3 How do students and faculty perceive the causes of environmental destruction locally and internationally, and the role of science in university programs? To what extent do the university academics and students perceive the science programs catering to the participation of women who have a limited access and low participation in science and technology? How is competency, in the dominant scientific sense, defined by the science academics? What is the corresponding view from the indigenous perspective?

Issue 4 How do university academics and the indigenous people perceive *social responsibility of science* vis a vis the harmonious coexistence of people-environment system? How are these related to culture, gender and or class structure? What is the current status? What more, if any, could be required and how could this be attained?

Issue 5 In the Ugandan setting, what are the perceptions of the scientists towards sharing of knowledge across disciplines? How are the structures and programs in various science departments facilitating the sharing of knowledge related to environmental science? How, if need be, could science programs at the University be structured to reflect interdisciplinary and a conceptual pluralism integrative of sociocultural realities, including the current ecocrisis in Uganda?

Issue 6 What forms of interdepartmental and intradepartmental interactions take place in science and science education? What implications do these have in the democratization of science to embrace development and indigenous knowledge and social interactions with the environment? How are indigenous, intuitive ways of knowing and local knowledge, including holistic participation, perceived, encouraged and realized?

Issue 7 What are the perceptions of university science academics in relation to Uganda's development options? How are these explained in terms of their implications for environmental quality and sustainability? Are solutions to national environmental problems seen as successful or constrained? Who or what is victimized in these explanations?
Issue 8 In the view of university academics, are the science and science education programs in Makerere University sufficiently comprehensive to respond to the current environmental degradation in the country and for the future? How best could science and science education programs be revisited to equip university graduates with the skills to use science locally to meet the needs of people? What values need to be infused, with what type of goals, objectives and procedures? How will this affect the current university structure and professional ethos of the academics? What are the science, technology and national environmental policy implications of these challenges?

These questions - which also served as the interview and focus group discussions guide - were fielded during personal interviews with university academics, students, and government officials. They were also presented during the focus group discussions and personal interviews among rural elders and high school science teachers. By seeking answers to these questions during focus group and joint workshop questions among the participants, the study sought to gain insights into dominant paradigms about the social and ecological implications of modern science and technology. Dialogue on these questions or their paraphrased equivalent opened up opportunities for participants' perspectives to emerge. The responses which are presented in the subsequent chapters of this study also inform on possible curriculum considerations for change in science and science education. In the analysis of the views, I explored an integrative principle that could lead to a critical reconceptualization of education which embraces collaborative generation and application of science in concert with some aspects of indigenous ways of knowing, valuing, organizing, and acting in the environment system for sustainability.

The flexibility of the study also accommodated various participants' questions which facilitated opportunities for dialogue. The use of a qualitative research approach created an atmosphere for sharing understanding pertaining to these questions. The implicit assumptions, embedded in the agenda of educational science and science education programs were conveniently accessed. In other words, the focus group discussions, informal guided interviews, and participatory workshop strategies provided a medium for accessing the participants' perceptions of the scope of issues embedded in the auxiliary questions. The qualitative approach also occasioned possibilities for rethinking, internalizing, initializing and acting upon those educational strategies which require a shift in the beliefs, values, knowledge, and social organization in relation to the environmental subsystem. As for the focus group discussions in which I was a participant, my presence and role in the workshop as a moderator coupled with that of being a participant created an atmosphere of collegiality which enhanced the free flow of discussion.

3.4.2 Informal Guided Interviews

Informal interviews constituted an invaluable means of generating insights about participants' experiences of themselves in their worlds. Informal guided interviews were a particularly useful medium in reaching the university academics who found it impractical to join the focus group discussions. This technique was also employed among indigenous rural elders in order to seek further elaborations on some of their responses during focus group discussions. As noted by scholars like Sommer (1988) and Graham-Brown (1988), informal guided interviews provided a means to venture into the "uncharted" region of everyday life, where the best witnesses were the participants themselves and led to a significant discovery about beliefs and action-dynamics in the participants' ecosystem and sociocultural setting. Keeping the research focus in mind, the kinds of questions raised during informal interviews were highly dependent upon the context but mainly consisted of general, attribute type of questions which sought description, opinion and/ or explanation. My preference for less structure in interview items was in the interest of giving greater control to respondents (rather than presenting a storyboard and dictating informants to tell their stories in a linear form). Five to seven broad questions about the topic from the list above were used, supplemented by probe questions in case the respondent had difficulty getting started or was seeking clarification, through detail, contrast, or examples. In this way, as a listener, I clarified uncertainties with follow-up questions. As Piaget points out, an the outcome of such probing is that "the answers given continually inform the evolving conversation" (quoted in Reissman & Kohler, 1993 p. 55). The questions posed sought not only clarification but also provided insights into the structure and organization of processes, contrasts and relationships. In all situations conscious effort was made to keep the questions explicit in relation to the research focus. The interviews also used replication by asking for the same information in a number of different ways.

The main challenge in using a qualitative investigation arose from the need to constantly distinguish between levels of various participants' lives, what Goffman (1959) calls "front stage" and "back stage". This distinction is particularly important in Uganda where there tends to be sharp contrasts between views of the "educated", like the university academics, and the traditionally immersed indigenous people, in the rural areas. Even within each of these categories, the study anticipated distinctions in terms of gender, class, position and other characteristics. This required strategies for gaining access into the "informal" and "inside" world of each participant and creating situations to facilitate the open sharing of views. My engagement in this study taught me to view, think, and conduct research from a problem- setting rather than a problem-solving perspective. Because qualitative research approaches are associated with procedures that create more open-ended, collaborative, and participatory involvement of informants, the element of problem-setting or problem-posing was enhanced in this study.

In my interest and inquiry into worldviews, cultural times, cultural change and adaptation, social structure and how these provide a backdrop into indigenous knowledge, science and technology and environmental quality in sustainable development, a qualitative approach gave my research questions some flexibility by allowing the participants the opportunity to continuously scrutinize the research questions. In this way, the research questions and the statement of the problem underwent a process of constant clarification throughout the course of the study. The process of data gathering and data analysis informed the problem statement just as the statement informed the data gathering. In the rural setting, the participants effortlessly embodied themselves in the stories and experiences of their lives, carrying us as listeners into a past time or "world", recapitulating what happened to make a point. This tended to capture a moral perspective by highlighting the ideal and real, self and society, and people and nature.

In marked contrast, the responses of the university academics displayed the self as a disembodied entity from the events and/or issues. There was a tendency to speak about science and its applications as totally unrelated to people's life experiences. Accordingly, the study sought to allow adequate representation of objective and subjective factors (Denzin, 1978) as a means to provide a balanced perspective of the perceptions and practices of the university academics and the indigenous participants in relation to the environmental system.

The use of less structured and more open-ended questions in focus groups as well as individual interviews created a relaxed climate for interaction and availed opportunities to provide new ideas. Open-ended questions allowed respondents a great deal of freedom to provide the volume and type of information they chose. Close-ended questions, being more restrictive and limiting in response, were merely used to polarize opinions for further discussion. There was a trade-off in the account and usefulness of the information generated by open-ended versus closed-ended questions. The volume of data obtained tends to increase with openness of the questions (Stewart & Shamdasani, 1990), with a concomitant reduction in reliability and replication of data. In survey research, where reliability and other capability are critical, there may be need to increase structure in questions and to constrain the variety of responses. However, in focus group interviews and joint workshop discussions, this was not desirable because, as Stewart & Shamdasani (1990) have observed, the usefulness of information is gauged more frequently by the ability to draw valid conclusions about the topic under discussion than by the ability to replicate findings across many focus groups.

Open-ended questions allowed respondents to interpret questions and often elicited detailed explanations and examples. Therefore, open-ended questions helped illuminate the issues and perspectives espoused by a particular respondent. They acted as useful "discovery" tools in a world of uncertainty -- allowing one to gain hold of a view. Closed-ended questions were equally useful in seeking clarification, and in quantifying behavioral patterns. This inquiry thus applied both closed- and open-ended questions, often beginning with broad questions followed by closed-ended questions — what Stewart and Shamdasani call the "funnel approach to questioning" (p 76). This was particularly useful in this inquiry where the knowledge of participants was not under question. Rather, each participant had the time and freedom to express himself or herself. This allowed me to access each participant's intensity of opinion which was then open for probing in relation to the focal issues of the study. In this way, it was possible to access the level of awareness, the uninfluenced attitudes, specific attitudes, reasons for these attitudes, and the intensity of these attitudes, using the following type of questions:

> What do you know about ...? What, if any, are the factors that ...? Do you approve or disapprove ...? How strongly do you feel about ...? Why do you feel that way?

Because my behavior in the group communication influenced the effectiveness of the interview and workshop, I found it productive to encourage all participants to feed off each other's ideas and views. My role as moderator diffused into the role of a participant, who occasionally clarified and/ or "directed" questions. In any given interview, focus group discussion and/ or joint workshop, my task as moderator was to create an atmosphere of trust, openness and rapport at the onset because this set the tone and agenda for subsequent activities. The reassurance of anonymity, of valuing all opinions irrespective of scope or perspective, and of empathy and intimacy with each of the respondents were all very valuable in facilitating discussions. I would slip-in with a brief description of my interests, a story, or a personal experience, stated to accommodate my research focus and its concerns. According to Fetterman (1989), culture espouses a materialist or ideational perspective. He offers two definitions of culture. The classic materialist perspective of culture focuses on behavior. In this view, culture is regarded as the sum of a social group's observable patterns of behavior, customs, and way of life. The ideational definition of culture, also called the cognitive definition, views culture as comprised of ideas, beliefs, and knowledge which characterize a particular group of people. This second definition excludes behavior.

This study recognized the need for the study of both cultural behavior and knowledge to adequately describe the groups in the research settings. From a cognitive perspective, this study was concerned with linguistic data and its predisposition to daily discourse. How is reality defined? What are the facets, subcategories or subroutines of their existence, their epitome of priorities, and meaning in life? How do they feel and respond to each other and to the natural environment in the context of their ritualistic behaviors, dominant ideas, values, patterns of behavior, the subtle elements? The cognitive approach was useful not only in learning and writing about the intricacies of the subgroups and localities involved in this study, but also in understanding and describing its richness and complexity. In this way, I sought to describe and contextualize the data within the framework of the social reality of the two research settings, as seen through the eyes and experiences of the participants. I claim no heroic effort to capture a total picture of the sociocultural and environmental perspectives in the production and discrimination of knowledge and I acknowledge the existence of multi-layered and interrelated context.

From a phenomenological point of view, to do research is always to question the way in which we experience the world, phenomenology being the desire to know the world in which we live as human beings. And since to know the world is profoundly to be in the world in a certain way, the act of researching, questioning and theorizing "...is the intention of attaching ourselves to the world, to become more fully part of it ..." (van Manen, 1990, p. 5)

Interviews, focus group discussions and the joint workshop availed both the factual status of science and science education goals, and the teaching strategies at Makerere University. In the rural setting of Osukuru, information regarding the frequency, intensity and interrelation of past and current people-environment interactions to social, economic and political conditions and events was solicited and collected. The use of these techniques within the two settings in this case study was not meant to provide a representative sample selection as might have been the case with quantitative research, but rather to avail examples of a wide range of experiences. According to Nieto (1992), this kind of approach provides possibilities for generating sound hypotheses from even a small number of case studies.

The phenomenological dimension embedded in this inquiry sought to examine the nature or essence of science teaching and the particular experiences of science and science education of academics at Makerere University. Similarly for the Osukuru community, research questions sought the description and reawakening of their lived experiences in social and ecological settings. A phenomenological perspective and the use of systematic reflective questioning allowed the study to transcend the explication of a particular culture and social group, thereby affording the marriage of meanings of university academics and the indigenous rural peoples. This was also explicitly realized through the concerted attempts of the participants to articulate, through self-critical dialogue, the structures of meaning embedded in their lived experiences. Through all of these processes we were able to set our goals for dialogue and continually examine our concerns in order to address the strengths and shortcomings of the processes of knowledge generation and dissemination and its impact on people and environment. It was this intersubjective engagement of the participants that added a phenomenological dimension to the inquiry process. As participants, we came to recognize our need for each other in order to evolve and develop a dialogical relationship with the issues at hand, thus validating the phenomenon as it was ministered in our thoughts and materialized in our narratives.

3.4.3 Document Analysis

Compared with interviews, focus group discussions and the participatory workshop, document analysis is non-interactive (Goodwin & Goodwin, 1996). It involved gathering information from a variety of different kinds of written material. These included (1) *Visitation Committee Report* (1970) which evaluated the programs in Makerere University; (2) the current university science and science education program outlines; (3) some students' thesis reports the analysis of which facilitated the determination of study and research focus in Makerere University science and science education programs; (3) The *Government White Paper on Education Review in Uganda* (1992) and (4) The Uganda Constitution (1995) which set out several policy stipulations on equity, environment, development and the role of women were also among the documents studied. The latter two documents were helpful in assessing policy emphases on science, technology, development vis a vis social justice and ecological balance, and the perceived role of education in the science-technology-development interaction in Uganda.

3.5 Ethical Considerations

To ensure safe conduct of this study within research ethics expectations, a number of preparations were undertaken. It was necessary to access the cooperation of Makerere University and Osukuru Parish. This was realized through communication from the Chair of the Center for International Education and Development (CIED) at the University of Alberta, which is the coordinating office for my scholarship to the National Research

Council in Kampala in support of my study. This cooperation facilitated the receipt of the necessary clearance for data collection in all the research settings of the study.

In my interaction with participants, the ethical dimensions of the research were fulfilled by first briefing all potential participants on the background of the study and its research focus. Their role in participation was clearly explained as a voluntary endeavor, and a signed consent was sought. During some of the later stages of the study, I replayed all of the taped messages for interested participants and/ or provided a written record of interviews and discussions for their review. At the request of two Makerere professors and the high school science teachers, for example, copies of the audio-taped discussions were provided. This not only brought them closer as friends and co-authors of the project and provided social validation of the knowledge, it also established my accountability to the participants.

It is noted that ethical concerns potentially limit the researcher's ability to collect and report certain findings due to the sensitivity of various participants to the publication of some of their data (Bulmer & Warwick, 1983). During the focus group discussions and the joint workshop, I made some requests, including the tape recording of the discussion, but I assured all participants of their freedom of withdrawal at any time. There was a conscious effort not to coerce or impose myself or my views on the participants and informants. By shunning unconscious fieldwork tactics, including simulating friendship to maliciously extort information or surreptitiously reading or acquiring documents (Punch, 1986), I successfully honored my moral commitment to gather the (qualitative) data in an ethical manner. Throughout the study, I was able to demonstrate my responsibility and commitment to the participants in Tororo, Makerere University and other locations by maintaining a healthy level of contact and interaction. I treated all participants as *collaborators* in the research rather then as subjects of a study. By using pseudonyms throughout this document, I have not betrayed any confidences nor abjured strong obligations surrounding authenticity of accounts and implicit secrecy surrounding friendship and respect in our society (Mitchell, 1993). As much as possible, confidentiality was observed, and the study endeavored to offer anonymity to all participants. Intentional concealment is a result of Africans' traditional penchant for secrecy. To be clear and candid regarding self-identity is perceived by locals in Uganda rural communities as tacit proof of one's fundamental dishonesty. The concept of objective academic pursuits within these communities is largely meaningless as people are preoccupied with the pressure of daily subsistence. Therefore, the notion that expenditures of time and money have been made, without ulterior motives, merely for the luxury of studying social processes, structures and environmental resource use and management, is often incomprehensible. Historically, because of the poor performance and record of academics with the rural people, it is not surprising for the latter to hold researchers or academicians, seeking to work collaboratively work with them, under suspicion. The usefulness and validity of the focus group data was ensured to the extent in which the participants felt comfortable in openly communicating their ideas, views or opinions with me. My greatest task was that of conveying a sense of honesty of my search for, and appreciation of, the participants' views in ways that evoked their trust in me.

3.6 Extraction, Organization and Analysis of Data

The data gathered from personal interviews, focus group discussions, the participatory workshop and from the documents studied were analyzed according to the *grounded theory* methodology whereby the data themes and or patterns are based on and "grounded" in the data itself (Jacob, 1995). The grounded theory encapsulates an approach whereby the researcher, rather than approach data analysis with preconceived themes, proceeds from bottom (ground) upwards by systematic data synthesis and analysis to tease out initial concepts and meanings. The approach, upon which grounded theory takes its name, has the advantage of easing the researcher's identification of ideas, themes, commonalties and interlinkages that are not often evident in the mass of raw data collected. The "bottom up" search for categories, according to Merriam (1988), involves and facilitates the development of recurring patterns in the data.

The initial data sorting process took heed from grounded theory and began with intensive reading of transcripts from interviews, focus group discussions, workshop discussion, and extracts from document study. This was followed by the identification of the broadest possible categories in the data, a process sometimes called open coding, and the identification of a few themes sufficiently comprehensive around which the information could be organized. The subsequent stages involved the identification of consistent themes or typologies in each of the four data sources. The constructed categories of data would sometimes require each data source (interviews, focus group, workshop and documents) to be reviewed for additional evidence. This multi-stage categorization of data is described by Strauss and Corbin (1990) as axial coding. It was guided by "search" questions that guided the development of the research account (Wolcoff, 1990) where each category identified was guided by questions like: What is going on here? What is true about all the views of the participants at this setting and/ or documents on this issue? What is true about the group of participants or individual participant in this setting, in terms of class, position, and/ or gender? What is true of the individual participants, such as the elders, or the professors?

Prior to the data-processing stage, important discrete pieces of data winnowed from the categorization phase was recorded on individual cards with a view to discovering and revealing those essences that were typical of the various research settings. The reason for this approach of thematic selection in a data set is well explained by Fetterman (1989: p. 92) when he points out that "Patterns are a form of reliability whenever patterns of thought and action repeat in various situations and various players." Therefore the underlying strategy in this analysis was to selectively narrow the focus towards the research questions, in the search for patterns of thought and activities. The collection of undifferentiated views, descriptions of activities and experiences were then compared, contrasted, and sorted into gross categories which were gradually miniaturized until desirable and identifiable patterns emerged. Variants were useful in circumscribing the activities and experiences, and were invaluable in clarifying meaning. This is because patterns of thought, activities, and experiences in any cultural setting are interwoven, often facilitating the understanding of interdependence, and new patterns emerged at every stage of the analysis.

3.7 Validity and Reliability Considerations

A daily journal that I maintained, using first person narrative, revealed the patterns, associations and underlying concepts used in the inquiry (Douglas, 1976). As noted earlier, audio recordings were made whenever it was permissible. The collection and verification of data involved group participation in discussions, the preparation of field notes where possible following these events. This included quoting information sources to reduce bias. Cross-checking information by having participants verify the meaning was also used where need arose. Once the transcripts were completed, the participants again had an opportunity to verify the findings. This step was facilitated by the reproduction of parts or all of the taped and/or written information. This approach to validation of data was accomplished by making the transcripts freely available to the participants. It required extensive preparation and reproduction of the ensuing discussions, observations and the interviews. In this way, the study accorded equal accountability to the participants and the researcher for the outcome of the discussions. As a whole, the methodologies and processes employed in the study were an attempt on the part of the researcher to ensure that data collected and analyzed was not only valid and reliable, but also that the research results reflected a clear and representative picture of the research settings under study. Then participants' accounts were laced with social discourses and power relations which did not remain constant over time. Each telling and teller represented a possible version of the reality, therefore, the idea of narration involves the inevitability of alternative descriptions. According to Chafer (1990), this renders the traditional notion of reliability inapplicable in an inquiry of this nature. In the context of this study, validation was a process through which we made claims for the trustworthiness of our interpretations. *Trustworthiness*, not truth, was invited in the interpretation. Truth assumes an objective reality, while trustworthiness moves the process into the social world; and in the indigenous African context, storytelling is a form of art the "truth" of which requires "special reading."

To a reasonable extent, the study tackled the issue of validity and reliability by using a combination of methods and techniques for data collection, thus enabling the researcher to cross-reference data (methodological triangulation) and counter-check information with the various participants and focus groups involved (Barsaga, 1988). The triangulation process for validating qualitative data arose out of the use of the separate methods described above namely, interviews, focus group discussions, document analysis and the participatory workshop. Principally these four approaches were used to inquire into the same issue and on the basis of convergence of responses of each approach, accorded definite and credible establishment of accuracy of the responses. This process occurred naturally and easily in the conversations and involved testing one source of information against another to filter out alternative explanations and prove a participant's hypothesis (Goodwin & Goodwin, 1996). Validity was also attained by the triangulation between perspectives and the interpretation of theoretical frameworks and insights from the literature review and introductory chapters of the study.

Recognition of the importance of the participants' role in validating my transcriptions and reflections about the study led me to send transcribed copies of the focus group discussions, interviews and joint workshop to individual and group participants. Upon completion of the final report of this study, it is my intention to take the complete and approved thesis report back to Uganda and make copies available for students and other scholars through the University library system. In this way, Ugandans and other readers are accorded chance to critically examine my reconstruction and interpretations of the Ugandan reality to determine if it meets their representations.

CHAPTER FOUR

SOCIOCULTURAL DIMENSIONS OF PEOPLE-NATURE RELATIONS

4.0 Introduction

This chapter contains participants' reflections about people and nature. In the section *Nature and People: Some Recollections from the Past*, we encounter narratives and statements based on reflections and/or lived experiences of the elders of Osukuru Hills in Tororo District, Uganda. In Osukuru the indigenous Teso peoples' worldview and how they interact with nature and as a community was sought.

The elders, aged 50 - 84, shared their views during the focus group discussions, one of which consisted of men and women, and the other only of women. Some of the narratives and statements were obtained during follow-up personal interviews. Under the theme, *Social Organization*, some insights about how they lived, worked and shared as a traditional community as far back as they could remember were presented by the Osukuru elders. Such recollections were then compared to the contemporary social set-up in their lived experiences. This chapter also explores a theme on *Population, Gender and Environment* which examines the explanations of some Makerere University academics, high school science teachers, government officials and Osukuru elders on issues such as population growth in Uganda and/or their locality, quality of living, the finite natural resources, and women's role in the process of achieving environmental sustainability.

Under *Spirituality, Space, Time and Identity*, we encounter the Osukuru elders' perspective of how they make judgments and assessments, and how they perceive their place and interconnectedness with their cosmos. In the section *Indigenous Science and Technology* , we listen to some views by the Osukuru elders about traditional knowledge and its practical value. The *Schooling and Modernization* section of this chapter presents views of the Osukuru elders, Makerere University science academics, high school science teachers and government policy officials on formal schooling. In these views, some insights into the agenda and subsequent influence of formal schooling on people's overall vision of quality of life, of development and environmental care are presented.

4.1 Sociocultural Dimensions of Relations with Nature: Historical Insights

At Osukuru, my first respondent was Dikko, an elderly woman born in 1911. I found her seated quietly at the scanty shade of a shriveled and only tree in the compound. Apparently she was the only one at home. She knew from her son of my coming because I was asked by the *Boda Boda* (bicycle-taxi) owner if I was the expected visitor. Upon confirmation of this point, she asked him to go down the gardens to let her son and daughter-in law know that I had arrived. Meanwhile she provided me with an historical perspective of their Teso community in this locality and how they related to their ecosystem. She patiently explained:

> Up on the slopes of the Osukuru hills we had a very vital creeping plant, "Isukur", from which this place derives its name. That plant is edible. Culturally, we all left it for times of famine. It was very drought-resistant. It is also a thorny plant, and animals never dared eat it. It was carefully harvested and boiled and eaten plain, day in day out, and we survived even the worst years of famine. Down here by the homesteads we had a lot of banana plantations.
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> That cave you see there was our spiritual shrine. My grandfather was custodian of the powers, which were later passed on to my late husband lying here (pointing to a grave). In that cave there were drums; there were skins on its walls and on the floor, herbs, and smaller shrines for various ceremonies like rain-making; dispelling of calamities.
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> Down there in the swamp, we had very good clean water all year. That river never dried up on us even through severe of droughts. We fished there. Our people hunted, grazed, played, swam there. It was also a place for rituals. When the evil ones attacked a person, we had a spot for ceremonial dance and offerings far down stream by river Malaba: overlooking the now Kenya border.

According to Dikko, their lifestyle in Osukuru bore a symbiotic relationship with what nature offered in the surroundings for their livelihood. The mention of the *Isukur* plant as crucial to their survival through times of famine and the locality being named after the plant in itself signified their reciprocal acknowledgment of nature's hospitality, and nurturance. In her reference to the cave, the land, swamp, and the animal and plant life, and the way the people interacted with these implied that the indigenous communities had highly evolved attitudes of respect for the natural environment. She affirmed that the land and other natural systems are, in their perspective, related in a sacred way to all humans. When the focus group later got together, Dikko's recollections above provided a starting point for our discussion. Telling us how the vegetation, animals, and birds were when she was young in the 1920s, the elder Dikko said:

> There were a lot of thick forests here, right up on top of the Osukuru hills. There were many animals here; antelopes, deer, water bucks, gazelles, zebras, buffaloes, and various smaller animals like rabbits, hyenas, foxes, porcupines. Occasionally elephants would appear. We could also hear the roar of lions and snarls of leopards which chilled us with fear.
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> Many birds. In the morning, there would be that chorus of birds singing. *Ah* ! We could catch birds and animals. One could get some birds lying there out of old age. In dry season other birds came from all over the place in large flocks.
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> Now you never see them. A few small birds and tiny animals. That is all. People learnt to use poison from the factory to kill many of the bigger birds to sell to the Indians and other workers in the factory. Also when we started growing cotton, many birds would be found lying dead. In the olden days a little digging was sufficient to generate enough food for families, these days this is not the case. The soil is worn out. Besides, government demanded that people grow cotton. So we cut down a lot of trees to make way for cotton growing in the 1950s and 1960s. Slowly we have got used to making money. So even the food-crops now have money value, so people are tempted to sell even the food crops to get money for clothing, sending children to school, of course drinking and other needs. It is more pathetic for families these days with many children.

Dikko's recollections, interspersed by episodes of silence, were affirmed by grunts: "*Ah, Hah*" from the other elders, who all seemed carried away- their eyes staring in space. Mention of the abundance of forests and other living things projected a feeling that when they lived in this envelop of nature-abundance-seemingly remote or desolate wilderness, they never felt alone. It also portrayed to me a feeling that to them, such surroundings were alive and aware, with potentials for feeling. The demise or decrease of natural abundance was attributed, in Dikko's exposition, to the emergence of modernization in the area. She, for example, pointed out how the availability of the various acids and compounds which she simply referred to as *ikee kimusugun* (white man's medicines) in the factories, and the demand for bird and animal meat by the factory workers can be seen as having technologized and commercialized the originally indigenous ways of hunting and food gathering mainly for sustenance. She also stated that more birds and animals which used to be caught with small traps with white ants as bait, now could be killed in large numbers by poisoning or more frequent hunting trips. Nets for birds and animals also appeared. They did not know where the nets came from. But she pointed out that there were different net-sizes for fish which were also used for catching birds. A larger net-size also emerged for trapping animals.

On how natural abundance of the past related to their health as humans, elder Dikko explained how comfortable the old days were for the people:

> We had lots of cattle, goats, sheep, chickens, ducks and turkeys. The land was very fertile. A little digging was enough to generate a lot of food. We had many granaries of reserve food for dry season and for drought, should it come. We had various good foods. Rich, from the soil. Well prepared. We ate together. We had fruits. We drank milk, both fresh and sour, and drank blood from the cows. We had butter. Our skins and eyes were healthy and shiny. People were huge. Big boned, and very strong. When it came to running after an animal even through thorny bushes, it would be like a tiger in strength, and longevity. People could run for an hour without collapsing like most people these days. We lived long too. We never had bad teeth like you young people of today. Good food makes good life.
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> We had a lot of respect for each other. There was equity. There was justice. We knew we were answerable for many wrong-doing, one way or another. These days, people do terrible things and get away with it. There was not as much death as these days. These days, the youth are dying more than us, the older people. They die and leave us with the children to look after, when it should be the other way round.

Expressed by Dikko, the elders conveyed a conviction of wholesomeness, richness, and the diversity and balance of the foods they obtained through gathering, hunting, fishing and through the abundant yields of farming on the then fertile land. The good health, great physical strength and relatively longer lives of people then was conveyed as a sense of good quality of life which they do not witness in these modern times.

The Osukuru elders also recollected that every homestead had big trees where people rested and held various meetings and cultural ceremonies. Trees were not scarce in Tororo at all. To them, the spirits of sickness were in the forest and it was ecologically healthy to have these forests conserved under these kinds of beliefs. Of course the big trees provided shade. Each home had a tree or shrub which, besides provision of shade and in most cases fruit, also symbolized the traditional African identity with the whole understanding of the wilderness, naturalness and sense of oneness. Elder La Patan of Osukuru said:

> We have a belief that doing anything immoral in the wilderness, dishonors this lofty relationship and will provoke the anger of the spirits. These feelings are still very strong among us. This belief is slowly being distorted to a point where we are getting disillusioned somehow because of *ajenaanut nakwana* (the scientific thought and development). The rock are being excavated for these factories, and also constructing roads and housing; a process of which involves blowing-up and knocking down big rocks which were originally feared by our ancestors as havens for spirits.
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> Stone-demand for road and housing constructions here in Tororo are causing formally cherished natural features like rocks and very huge and old trees to be torn down. We, particularly the older folk here, are at cross-

> roads between the indigenous point of view and your (the scientific) point of view, which does not take into account the cultural concerns in any way. When you come to the seasons of the year, we had a different system. Now with some change in these seasons, our people are not well informed particularly when there is prolonged drought. During some periods of the year we experience floods without notice these days.
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> Previously we knew from January to early March of each year is the dry period, then rains came by mid-March to mid-June with a short spell of sunshine normally lasting two to four weeks maximum. Then another rainy season from about mid-July to October or latest mid-November. December was normally a transition month between the dry and wet seasons. But now the rainy season lasts through December and you find many areas being flooded. What is this? Our suspicion is that the blowing up of the big rocks by the construction companies has caused fury from the gods; or the cutting down of some of the big trees or forests, there is that strong belief that what we are witnessing is a punishment being unleashed against us by the spirits.

Responding to natural features like forests, rocks, mountains, swamps as awesome and worthy of respect was evident in this elder's view. To the Osukuru elders, nature is alive with powerful spirits embedded or identified with each of the natural features, with which people ought to foster rapport. This rapport was portrayed as involving good moral behavior "in the eyes of the natural majesties, the spirits" (elder La Patan) which were inseparable from the natural systems themselves. Portrayed in this revelation was a strong belief by elders that there is a proper code of behavior that should be observed lest the wrath of the spirits is provoked and unleashed upon the people.

Pointing out the prevailing blasting of the rocks as a sacrilege and lacking in respect, the elders conveyed great fear of these activities as forcibly bending nature to human will. Dikko remarked: "*neiretunia!*" to which (the day it will pay a call of retribution!) La Patan pointed out : *Eretu da!*: (It is already doing it!). These remarks by the elders were linked to their fears that the rude blowing-up of the Osukuru and surrounding hills for limestone and stone-excavation for construction work on roads and modern housing was responsible for weather changes and frequent droughts. The cause-effect analysis of elder La Patan's view would be disputed by dominant science which would disagree that the blowing-up of rocks causes climate change, arguing that climate change has nothing to do with a backlash by irate spirits. From an ecological point of view however, we might say that the elders' respect for and sensitivity to the quality of the environment and the pressures and tensions which continued degradation of the ecosystems impose on human activities and natural cycles are embedded in the indigenous belief system that we witness from these elders. Elaborating on aspects of modern life which contrast with traditional ways of the past, elder Dikko, elder Amu (elder Katan's wife) and elder La Patan simultaneously contributed:

> Food was not a problem. There were also no lazy people. People were disciplined, and all worked hard. If, due to an epidemic, a family lost all its cows, neighbors or relatives would loan him a small herd for a few years to look after. In that time, the animals will have multiplied enough for the family to be granted a smaller herd of their own by the original owner. That was the way of the people. (Dikko)
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> These days food is fried with oil from the shop which they just measure with little cups smaller than my cupped hand for quite a bit of money. We can no longer manage to produce enough groundnuts from the gardens to make our own oil. The soil is tired. The gardens are also smaller and fewer. People are now many. (Amu)
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> These days, we have to dig a lot more just to keep the family alive till next harvest. The land is getting less and less agriculturally viable. Where can one get that good life again? That is how we lived in peace in a state of self-sufficiency and equity. It is not like these days where war has destroyed our balance and ways of living. Armed thugs come and take away what has been our thing, including human life. It is all rotten.
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> To be happy these days, one has to be successful in studying at school. Get a good job. That is why we send our children to schools. Some manage and succeed and they come and help the other children, and help us also. The majority hardly come back. They disappear in Kampala and other towns. Your age-group no longer knows what *Kau* (one's origin/cultural identity) is. (La Patan)

In this multi-voiced response, the elders alluded to a number of their lived experiences. First, that they generally cooperated and supported each other as a community. Needy families and or individuals were propped-up with support towards self-sufficiency. Second, the elders also draw our attention to the continued collapse of their potential to sustain their daily needs due to degraded soil fertility, compounded by an increase in population. They also raised their increasing dependence on food bought from the shops and food-markets which only a few can afford. Elder La Patan particularly expressed apathy over the unsustainability of survival based on commerce. While citing people's invested hopes in sending their children to school as a way of fitting into the modern milieu, he also expressed disappointment over loss of allegiance to the community. Communities' food insecurity may be due to many factors for example lack of water or insufficient rain, and poor health among people could reduce or prevent productivity. It is evident from the narratives of the elders that environmental degradation has become severe. The most affected in these circumstances are the poor who have generally depended on the quality and stability of the environmental system to provide for their livelihood.

The elders also recalled that the introduction of cotton into Uganda in the 1910s was accompanied by use of *dudumaki* (DDT) as an insecticide against the cotton-ball worm. In her book, *Silent Spring*, Rachel Carson (1962) made it evident that many bird species were wiped out in Uganda, in places like Tororo and others where DDT was used as an insecticide as the birds would eat the poisoned hoppers and other insects. According to the elders, they were never advised or warned of any serious dangers of *dudumaki*. Dikko pointed out that they even smeared it on their heads to kill bugs and on their jigger-infested feet. This raises serious concerns about the need for public education on the use of scientific and or technological products among uninformed people whose lives could be at serious risk. The distribution of DDT in Uganda in the 1960s through mid-1970s would appear to have had a focus on maximization of cotton production for profits without regard for the health and safety of the participating communities nor of the biodiversity.

4.2 Social Organization, Spirituality, Space and Identity

The Osukuru peoples have a metaphor from which they generate insights into how things are and related to them and to their natural environment. This metaphor also links with their economic behavior, thought, embedded feelings, values and organization. Giving an example of how a sense of interconnectedness or communality is reflected in their daily discourse, the traditional greeting was chosen by elder La Patan:

> In this place, when you meet somebody and ask: *How are you?* We say automatically: *We are fine, everyone is OK* For us this is the absolute thing. *We are healthy nobody is yet sick*.. Yet for you, (the educated) when you come to the village you find us bare footed, sleeping in grass thatched houses; our food may appear to you as an unbalanced diet, etc. For you this may be considerations for a poor quality of life. For us it is about good health for *all*:. For people, our land, and all that we live by.

In this very important greeting among the Teso people of whom the Osukuru people are part, elder La Patan's example exemplified their traditional emphasis on the importance of mutuality in relating themselves as they do with the natural systems. Such an emphasis seems to be placed on the fact that as humans, they (or we) are dependent upon other life forms for substance and harmony. They are part of a biosphere composed of a delicate balance of interacting life forms sharing a common space. The "us" and "we" signifies, from the elders' perspective, a maintenance of one's place in a habitat for which reciprocity and one's respect of the well-being of all -- *ejok kere cut* -- are valued. Hunting, fishing and gathering were all communal activities. Whoever made a kill of animal, or caught and gathered most, took the greatest share but still made some distribution of what was killed, caught or gathered. Elder Katan described what happens after an animal is killed by traditional hunters:

> The one who spears the animal takes both of the hind legs, the chest, and a piece of the liver. The remainder is apportioned to the

> other hunters. The accompanying children are normally given the intestines and some ribs. The head of the animal is spared for the chief elder of the community. The kidneys and heart for the fortune-teller. No one contests this sharing because eventually on reaching the community, the one who made the kill would eventually share his large animal with the others, with all certainty.

One might quickly notice that inequity still exists in such sharing. In traditional indigenous African systems however, the elders pointed out that no person apparently ate more than the other, explaining that later in their homes, there would be more invitations to share meals often by those who had more.

To date, the elders further explained, equally communal in traditional communities are the shared tasks of sustaining their body health, replenishment of their households, repairing and construction of their shelters, making of tools and implements, and embarking on long and arduous journeys. Being embedded in the socio-cultural milieu, the traditional organizing principle explained by the elders appeared to be one modulated by the role of stasis, of changelessness which, however, does not mean a passive surrender to fate. As Smith (1957) and Thomas (1958) point out, traditional societies have managed with extra-ordinary adaptation to the demands of even the toughest geological times like the Ice Age. This communal coexistence did not, however, imply a totally coherent group of people as Elder La Patan clarified:

> We had conflicts among neighbors and within families. But we sat down to discuss the whole underlying causes, effects and made resolutions. We mapped out peaceful coexistence strategies. These talks would be attended by all elders from several clans if necessary. It also occasioned a ceremonial bath of the accused and accuser, and a big feast given the family or families involved.
> After a war, friendship and goodwill was shown by the intermarriage between the sides involved.

La Patan also noted that in acquiring new territory, their people were either raided by other tribes or they themselves did the raiding, but peace and unity was established by forging closer ties, for example, through intermarriage. With this strategy, it was clear that the indigenous societies had well-defined peace resolution strategies in which kinship was valued while any possibilities for violence against each other were potentially reduced.

At family or clan level of conflict elder La Patan explained as follows:

> If someone committed a serious offense like eloping with another's wife, a theft of something valuable like animals, it became every one's concern. The culprits would be publicly charged, required to confess their wrongdoing, and later assigned elder counselors. Such serious cases were rare, but when they occurred, they were decisively handled by the elders. In extreme cases the clan could vote on eliminating someone by exclusion, or

> even killing by spearing. Such taking of a person's life on these grounds was rare, but when it was done, it was to offset further torment due to perpetuated activities.

Here elder La Patan let us know that their indigenous knowledge system has a "value system" which provides frameworks for judging good or bad, right and wrong, acceptable or unacceptable categories. A value system, as explained by anthropologists like Foster (1962) gives stability to a culture by providing planes of balance, justifying thoughts, discourse and actions. The cultural controls La Patan described also invalidates deviant behavior through punishment, including threats of supernatural interventions. Elder Dikko provided an example of how supernatural powers were invoked to instill discipline:

> Stealth in anything was curbed by fear of sorcery. An afflicted person would go to our traditional doctors, or seers, and request for a curse to be cast on the unknown person(s) responsible for a wrong-doing. The seer or doctor would arrange a special ceremony involving drinking of a local alcoholic brew with tubes. This would be meditatively drunk by the doctor and his assistants in the presence of the accuser. On the beat of a drum, they would all say: *Whoever has committed* ...(name of offense)... *get this spell!* (Thrust of hands forward to demonstrate how the drinking straws would be thrust into the beer-pot). These words would be said with a level of commitment, and concentration that the doctor would often get into a trance.
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> I assure you, the culprits would sooner or later get the spell. It could be a disease, loss of property, lightning could strike the person, anything! I have personally known of people who, after a calamity, confessed their secretly having committed bad acts like stealing a cow or something.

On whether there were ways of a culprit seeking an anti-sorcery. She said:

> Yes. But if a traditional doctor was known to shield and protect wrong-doers, the sentence was death. Very brutal death. His clan and that of the afflicted would meet. To offset a clan war, he would be tied with many layers of dry banana leaves and set on fire. *Bas!* (That would be it!)

According to Dikko therefore, promise of calamity or heavy punishment were effective deterrent devices which established conformity to cultural values, not excepting the witch doctors who, up to date, are accorded a lot of respect in traditional circles. Dikko's narrative contrasts the contemporary individualization of authority in modern societies, where possession of hierarchical power of any kind tends to be synonymous with freedom to usurp the weaker or marginal folks. The elders also gave some examples of specific ceremonies which used to be performed based on need. These included a fertility ceremony for a woman who was believed to be sterile and the rain-making ceremony. I posed a question about whether there was a ceremony for infertile men. In a din of laughter they said no. Men who were infertile were mostly administered herbal treatment.

From a Women's focus group discussion over this issue, Kossy, my research assistant gathered that in their tradition, a woman was seen as *"Toto a'kwap"* - mother of creation. One of the women's focus group participants, Timoto, who had undergone this ceremony and had a son about a year later, hesitantly explained the process to Kossy:

> Early in the morning before sun-rise the grandmothers and a medicine mother took me to a swamp, and stood me on an ant-hill, stripped to the waist. I was bathed with herbs as they made me repeat certain words (words not provided). Later we left a live little chicken on the ant-hill and returned home without looking back.

A striking element of this fertility ceremony is the strong traditional association of a woman with nature. On a follow-up interview, Timoto expressed a feeling that men, although strong, often engage in transient activities: "*Ilatosi ngun.*" Timoto's remarks about men did not in anyway underplay their traditional connectedness and sensitivity to nature. Her point was related to the reproductive trust of carrying life which, although a joint project between man and woman, bore heavily on the integrity and balance of womanhood which she equated with that of the earth. This understanding was explicated by her reason for the choice of an ant-hill at the swampy location in carrying out the fertility ceremony. Timoto had a view that these features are sacred. Each ant-hill located in the quiet hence spiritual grounds of swampy places was a host to the life of ants which had a queen. These creatures never inhabit a place unless it was safe and potent with life and cosmic energy: "*neejai asiilwany.*" By taking a bath and saying a prayer for fertility at such a site, a woman would harness this energy which would attract the spirit-children to her - making her potentially fertile. The chicken left behind is a gift to ant-hill spirit for making the connection.

The elders in Osukuru also explained that the rain-making ceremony took place at the cave by select individuals the composition of which depended on the spiritual leader's insights. Dikko mimicked, to our laughter, what was said at a rain-making ceremony:

> *(Okwe Toto, Ipupi do so erono cut. Kingarainai so)*
> ***We are now in dire need, mother nature. See us. Reach us. Help us.***
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> Then there would be an offering of an animal. People feast right there. The shrine would have a special dish of food offerings for the spirits. That food offering would be left there for the spirits.

At this point, elder Katan, being a Christian clergy, displayed some discomfort, squirming in his chair and muttering to himself for a bit. It was apparent to all of us that he had something he really wanted to say but had some misgivings expressing it. Then with some spontaneity he recounted how his father, a traditional spiritual leader in the Osukuru community and to other clans beyond, involved him in a rain-making ceremony way back:

> My father had been given the spiritual and cultural leadership of this clan. One day in 1970 he surprised me when he walked into our classroom with the headmaster of our Osukuru primary school here. I was in primary seven then. I thought something drastic had happened at our family to warrant his coming for me. It was a relief when the headmaster explained my father's coming as an invitation for a special field trip to be undertaken by the whole school.
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> The sun was extremely hot and had been for long, 1970 being a very dry year. Many people were faced with starvation. Our animals were dying for lack of grass for grazing. The planting season had been long overdue. It was about two o'clock in the afternoon. My father led about three hundred of us out of school, and we slowly headed towards the cave up there on the Osukuru hills. We reached the cave. *My father looked a completely different person*! His mind, his focus, seemed very, very far. He seemed to have a different identity. There was an aura of mystery around him.
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> At the cave, he stopped us at the entrance, instructing us to maintain absolute silence once inside the cave. He also requested that we not be afraid of the big snakes in there which we were to respect lest some calamity befall the tribe, like starving to death. Commanding no one to remain outside of the cave, he led us inside. About twenty yards into the cave, a big snake was indeed resting at the cave wall on a kind of crevice. We were really scared.
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> Signaling us to stay by the snake, he went a little deeper into the cave and started beating a drum gently, making some utterances. We stood there, our knees shaking with fright, for perhaps thirty or so minutes, I cannot tell. Then there was a huge gust of wind into the cave from outside. My father hurried towards us and urgently whispered *Run back to school. Do not make any noise, nor look back. Go!* We barely made it to school. The rain that fell that day was such a heavy torrent. It abated at about seven o'clock in the evening.
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> When I got home that evening, I mentioned to my mother about what happened at the cave but she hushed me up, cautioning me not talk about it to any one. Not even to my father until he himself decided to. I was and still am fascinated by what happened, what my father did, and what powers my father had. As I grew up, however, my interests switched to being a Christian clergy, and my father must have found it difficult to share these mysteries with me. In a way I feel a sense of loss.

What is common to these examples of ceremonies is the reciprocity between people and the natural environment, which is a crucial ecological ethic. By calling to Mother Nature to reach out and help them, and respecting the snake at the cave, the peoples of the Osukuru community displayed a caring attitude for the land and its biotic community. By calling out to nature for rain discloses the peoples' trust and dependence on the providence of the natural ecological cycles and of a presence of a cosmic force or energy to which they were honor-bound to continually attune themselves. The story also reflects another dimension, namely the authority of the elders not only in the spiritual capacity of getting the rain to fall, what Arne Naess (1985) would probably associate with as a process of aligning oneself with the cosmic being, but in setting the participation mode of the others.

With the kind of experiences and beliefs expressed by the Osukuru elders, I sensed that they encounter and engage the natural environment with a rapport[11] that posits it as redemptive and liberating because they speak to and identify with it. It confers upon them a sense of identity, and unique placement and which they call "*Kau*", as elder La Patan assertively explained:

> This linkage with *Kau* is how you strengthen yourself, your people, your children, with and for what we are. *Kau*, is your *place*. The spirit arranged that you be born in that place. Your umbilical cord lies there, preceding your call back to nature. *Kau* is a peg to which your excursions in life are tethered to. Your journeys forward are determined by this spot. It is what attracts your future and determines all your journeys.
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> When we greet, we ask: How are the people from *Kau*? Your successes and failures are determined by *Kau*. You, the so-called educated, have missed this understanding. To you it is simply a place of birth. *Kau* is like a spring. The further you pull-out, the stronger it should pull back. Do you have that feeling in you? I do not see that among the educated. I am pleased that you are asking these questions from us. That is a good sign.
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> *Kau* is strength. It is more than a permanent office which has a beginning and an end. You have had *Kau* before you were born, you will have it after your life leaves here. Do not let anyone take it away from your thoughts. Your coming and talking to us has touched me. You remind me of so much I hardly allow myself to think about.

When elder La Patan was making these statement, I sensed the seriousness he and other elders around attached to these words. I noticed this from their facial expression and body composure. They all listened with a unique form of reverence. La Patan movingly continued:

> These kinds of things hardly take place anymore. Foreign religions have completely made us strangers to our past. Those who practice it do so in secret for fear of reprisal or torment by the increasing number of the formally educated. When it comes to droughts, people glue their ears to radios about weather forecasts. But their rains are no longer following the

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[11] *The external influences of Christianity, and of cash economies pushed by state development policies, have tended to reduce this reciprocity. As will shortly be pointed out by the elders, most youth and educated people cherish material goods to concerns about ecoconservation. For some Christians, biblical passages like the prophetic vision of the apocalypse is used as an excuse for abdicating their responsibility to be good stewards of God's creation.*

> pattern we used to have. Often they tell farmers to get ready for planting in a few days, but the rain takes months to come. The youth of today will never know our old wisdom. My advise to you, the young people at school, is to keep on these kinds of contacts you young man are doing. Knowledgeable people are not completely gone from our amidst.

I found myself struck with a deep sense of awe at this point. We stayed in silence for a number of minutes without anyone talking. Elder Katan's wife, Amu, diffused this quiet by bringing in some tea and snacks for us. As we took the tea and snacks, elder La Patan slowly continued:

> I never went to school. My father taught me a few things. They click back as we talk. You see, these days we have to struggle to look for money in order to buy food. The late old man in this house was the person you should have met. He was a chief in the sub-county. He went to school. He knew how to read and write. But he learned the ways of *Kau* from his mother. A very powerful, intelligent and visionary woman of this clan. She taught him everything, and he was a good pupil. And he led and sustained our traditional spirituality: our identity and linkage with *Kau*.

To my naive thinking, *Kau* has always meant home, a geographical landscape where one was born and grew up in. With La Patan's reference to the erosion of linkage to nature, I was reminded of my own scientific background which had tended to give me a mechanistic view of things. With my grounding in Physics, my awareness of the immensity of space --both visible to the eye and in the quantitative analysis of sub-atomic and galactic configurations -- has always made life (in any form) look an exception in the vastness of space. My undergraduate and graduate interactions with modern Physics, classical dynamics, quantum mechanics, and statistical mechanics invited views of the Earth and all in it as an infinitesimal speck of cosmic dust. Life on Earth assumed a position of transition which would soon (in geological time) disappear when the sun, itself an unremarkable and small star, inevitably enters phases of decline. This image of "being", that life on Earth is transient and not unique is sometimes emphasized when I watch with a scientifically-inclined mind movies like "Star Trek: Deep Space Nine". Programs of this nature emphasize a sense of space as passive and empty of life and meaning. Very much in contrast to elder La Patan's sense of *Kau*, the space I envision with a scientific and technological mind consists of regions that humans and a few other life forms inhabit, move through and explore, but rarely identify with. Elder La Patan's discourse suddenly opened up a new sphere of perception and meaning of *Kau*, as a spiritual and cultural dimension. It came as new insight to me that *Kau* is more than one's linkage to nature, to *place*, and *space*. As noted earlier by elder La Patan about a traditional greeting, *Kau* portrayed an indigenous sense of the cosmos which is inherently timeless.

In these remarks, such a treatment of land and of all the natural environment with a feeling of obligation and reverence is what Lopez (1986) referred to as entering into a relationship with the land, and seeing ones' own being reflected and blessed in it. To elder La Patan therefore, *Kau* -- and being attuned to it -- is to be shaped by the land in ways that identify and dignify one's life.

Among the Osukuru elders therefore, humans have an intense and close relation with all aspects of nature. To these elders, harmony with nature, reverence to and identifying with it is encompassed in their concept of *Kau*.. The scientific view of nature, now generally termed Baconian by many scholars like Capra (1982), Adams (1993) and Merchant (1980), is one of the physical universe, described as though homogeneous by a set of laws. This picture of the universe views events or phenomena like changes in the weather and seasons, pollution, deforestation, hunger and disease among people, and decrease in biodiversity as inevitable outcomes. These are simply seen as action-reaction or explained as previous forces and their causes. The scientific rationality underlying such a fatalistic view of nature and its effects on people is a belief in the predictability of the physical universe. Jonas (1974) for example, says that "In the working of things there are no better or worse results and there is no 'good' or 'bad' in nature" (p.69). For example, such an analysis of 'natural' events exalts and legitimizes an explanation that pollution is not our choice or intent, but a consequence of well-intended previous actions -- it must happen as it happens. Jonas describes a scientific view of processes in which the concept of nature deserving respect gets overshadowed by concerns for the efficiency of processes and the control of variables. A scientific view of the world put forward by Jonas fits in the framings of monocultures of the mind (Shiva, 1992), and makes us think in terms of monotonic values. In particular, Shiva notes that improvement and growth in a monocultural paradigm of modern science blocks out thinking about sufficiency, balance, and appropriateness. Capturing a similar argument, Caroline Merchant (1980) points out that a framing of nature based on Bacon sees nature as passive and as hiding secrets from humans, hence deserving aggressive exploration. Merchant (1980) argues that this scientific understanding of nature mirrors contemporary male-female relationships saying:

> The 'searchers and spies of nature' are to discover her plots and secrets. This method, so readily applicable when nature is denoted by the female genders, degraded and made possible the exploitation of the natural environment. As a woman's womb symbolically yielded to the forceps, so nature's womb harbored secrets that through technology could be wrested from her grasp for use in the improvement of the human condition. (p. 169)

This exposition by Merchant and other scholars alerts us to the aggressive, violent, curious and exploitative attitudes which science and technology has towards humanity and nature, rather than nurturing, respecting and identifying them with a reverence as in the way of *Kau*, the way of the Osukuru elders.

Kossy and the women's focus group discussions presented a view of scientific and technological developments in industrialization that engendered blindness to ecological systems and to moral values. They based this on their observation of the attitudes and behaviors of the common breed of church-goers, saying:

> The scientists will one day realize too late that we are dead; that the life we are leading now is dead. We are just like the end-time Christians. Poor, blind, wretched. And they think they are very well. You see the Christians of today? St. Peter's church here in Tororo! Do you know the big strong Christians in that church? Do you know who they are? These are the men who spend most of their time in bars.
>
> These are the men who, even if they have one wife at home, have many concubines in Town. These are the men who are making the young school girls to drop out of school by impregnating them. Yet these are the strong fellows who sit up front in the church pews. When preaching goes on they are very attentive, but they are blind, they are naked, and everyone thinks: *That man comes to church every Sunday. He is seen as a good* (rich) *Christian*. You see? *This thing is not there*!

The women's focus group talked about commitment, maturity, and responsibility to oneself and to others. In the understandings of their group, there are no such indicators of critical awareness and deep concern that inspire responsibility from among the educated in civic positions of responsibility. They based this interpretation of the observed behaviors of men whose public image demanded better:

> A big man is not aware that what he is doing is bad. *What am I doing? What am I doing - an old man of forty? What am I doing to a girl of sixteen?* He does not ask himself. He does not get shocked why he is doing such a thing.

These observations of the Osukuru women calls attention to the moral collapse of the "big" men, the educated and those in political and economic positions of power. The women participants expressed strong contempt for this lack of empathy and caring for innocent young girls who ought to be given the chance to grow to mental and physical maturity. This ties closely with three characteristics of modernity: the separation of object from subject; the drive to dominate nature; and, as feminist scholars like Merchant, (1980) and Keller, (1992) would point out, the establishment of a master-slave role -- the domination of women. Similarly, the Osukuru women's focus group see men as exploiting women, particularly young innocent girls in immoral sexual exploits that are devoid of responsibility, respect and caring. The women see the surface piety of church-goers as lacking in deeper communion with the virtues promised by religious teachings to its believers. In a parallel argument, modernization through industrialization/modern science and technology has not delivered its promise of a better life for all. This malaise has its story which the elders remembered quite well. In the initial stages of contact under British colonial rule, some Osukuru elders recall great antagonism to the changes suggested or imposed by the colonial government which, in Tororo in the first decade of 1900, was interwoven with Christian Missionary efforts. The elder Dikko recalled:

> They came looking for my grandfather because he was in charge of the cave with all our traditional drums, trumpets, and other regalia for various traditional worship. He escaped and hid for a long time. But they discovered the cave and took away everything in the cave. The shrine was burned. Children, mainly boys, were arrested and forced to study Christian religion and reading and writing. To what the older people did, one elder responded: The older people were very fearful. The sight of the white men sent chills down people's bodies. Slowly people succumbed to the pressure of accepting Christianity and schooling. We were drilled to reject indigenous and to disregard counsel of the elders and to obey the teachings of the white priests.

Dikko's recollections affirm the authoritarian approaches of early missionaries in forcefully converting the African communities to Christianity. The elders explained that the church effort mainly concentrated on the youth. Christian teachings and instruction in English language, vernacular and arithmetic constituted the curriculum. The elders also pointed out the forceful denigration of traditional values in the church teachings, denying participation of converts in traditional worship of any kind. Simultaneously, spiritual leaders were hunted and the traditional shrines destroyed by the local government defense units. To the elders, this marked the destruction of tradition in their midst, as elder La Patan remarked:

> A good Christian convert was said to be one who shunned old ways. So the converts began separating homes from traditional large compounds, and they farmed and eat alone with their wives and children.

On the subject of the motivation of families to have many children, elder La Patan said:

> When Christianity came, we were being encouraged to have many children. In fact, some of our own people who knew our traditional birth control methods mentioned it to the priests. This led to the whole condemnation of traditional birth control. Now in the village who even thinks about it? It is

> easier for people to surrender to fate as preached in church than to exercise practical control.

To elder La Patan, the modification of the traditional extended family grouping by young men towards a nuclear biological family was a result of Christianity. In his elaboration, he explained that the early Christian missionaries and the socialization of their schooling encouraged the converted families to have more children by arguing that children were the gift of God. He also suspected a hidden reason was to boost the convert population. Ecologically, the trend towards more independent family units led to land fragmentation as each home needed its own land for food production and later, for cash cropping. As pointed out by Joan Vincent (1964), the cotton boom decade of the 1960s enhanced the commercialized, and hence, competitive use of land in Teso. One ecologically destructive aspect of the cotton campaign was the clearing of natural forest cover for arable land acquisition. In social terms, commercial agriculture established commercial labor over the indigenous communal system, the former now firmly entrenched. An example of this was raised by a youth I found harvesting corn with some hired help in Osukuru. He had a simple explanation:

> I find it cheaper to hire a few persons for "*lejaleja*" (casual laborers) instead of paying or arranging for good and drink for "*aleya*" (fiesta-minded friends and relatives). I'd rather let this aspect of tradition slip into the past.

This commercialization of agriculture or any construction work in a family home, and the use and availability of money was viewed by the Osukuru elders as having slowly eroded the frequency and intensity of reciprocal agricultural work patterns. The indigenous collaborative mechanism of communing and sharing was now seen as being dwarfed by a centralized command structure motivated by the 'state' and market forces.

Inevitably, the old culture of the community, according to the elders, has slowly undergone a re-organization in which the allegiance of youthful persons has shifted in response to market forces of modernity, job and wage opportunities which came with shackles of centralized state and corporate control and command. The traditional reciprocal social interactions were reported by the elders as having been replaced by cash transactions which brought competition and conflict. Political value, competition over the organization of work, and a shift in measures of success were attributes which the elders described as having swept through their traditions, causing alienation from the ways they respected and interacted with people and nature.

4.3 Indigenous Science and Technology

It is well known that indigenous knowledge, also called traditional or local knowledge, evolves from the interactions between people and their social, cultural and natural environment, culminating into an accumulation of experiences or knowledge and insights. This form of knowledge typically characterizes all cultures, and it spans the whole domain of a given people's existence including language, history, art, music, psychological, economic and political frameworks. It is important to note, as Berkes (1992) points out, that indigenous societies have inherent variations in their knowledge system. These variations are determined by cultural dynamics in the form of social attitudes, beliefs, principles and conventions of behavior which also shape their worldview, and hence modes of action. During my focus group discussions with the male and female elders, I raised a question relating science, technology, and environment and their traditional use of woodfuel. I made an observation of the traditional cooking over an open three-stove wood fire in the kitchen which in some homes also serves as a sleeping hut. In the absence of chimneys, with few or no windows, such a hut easily fills with smoke causing unpleasant choking effects leading to respiratory and eye ailments. Concerned about these health effects and wood energy conservation, the elder Dikko pointed out:

> Smoke in the roof is good. The grass in roofs will stick together. The smoke soot has a glue in it. This strengthens the roof, grass, and rafters are made more sturdy. Those roofs do not leak in the rainy season; and we do not have to replace the roofs often. The wood-boring bugs cannot attack the rafters. When we sleep in those huts, we have warmth and fewer mosquitoes at night. Those stoves you talk about do not give us that.

While Dikko did not deny the possible health effects of smoky huts, she exposed the critical area of resistance to wood energy conservation stoves as having wider interests and concerns to them. Thus to change the open three-stove would call for an innovation which would include roof-preservation and space-heating at night because most of them cannot afford blankets or bed sheets. The smoke from the open stove also offsets mosquitoes. Clearly surprised about these revelations, I conceded to being teased about my limited knowledge. This led to several narratives of their reservations about some scientific innovations. It provided the opportunity for me to seek further examples of how modern science and technology has failed to meet their expectations. With eager response, another woman elder Amu pointed out why they do not like the hybrid maize (corn) for food.

> It is big, but tasteless. The flour is too white, and the meal not nutritious as our local though tiny breed. We now grow the hybrid for making waragi (local potent gin) and for sale. The problem is that it wears out the soil and needs fertilizer.

It would appear that the introduction of this corn has not in anyway met the original dietary improvement intended. Instead, it has promoted alcoholism and soil degradation.

Elder Katan, amidst our laughter, narrated a disappointment over his nephew who had undergone some training as a veterinary scout. Apparently way back in the 1960s, the Ugandan government trained veterinary scouts, one in each parish, in the cattle-keeping areas. This project was intended to encourage peasant farmers to raise better quality beef cattle for the Meat Packing Factory which opened in the mid 1960s in Soroti Town. Fresh with the new ideas from Veterinary Science about quality beef cattle, his nephew made a campaign for the castration of bullocks so that they would fatten at maturity. Elder Katan recalled the strong opposition of the peasants who opposed castration for the simple reason that castrated bulls cannot grow the much-needed hump necessary to hold the yolk harness in place. This harnessing of bulls in the traditional sectors makes them indispensable for transportation and for pulling the plough at fields during the ground-tilling seasons. The elders also expressed dismay over the gradual loss of interest among their communities for indigenous technology which they said suited their type of traditional crops and cropping patterns. They argued that their indigenous technology enhanced communal work. They described the process of making of hoes (see Appendix B1) and other tools from ore. The whole exercise from collection of the ore, the high temperature smelting, molding and final engraving of clan symbols on the various tools were simply routine. These descriptions made by elder La Patan and elder Dikko in the hushed silence portrayed that the knowledge, skills and cultural symbolism that went with the technological cycle constituted a large, coordinated production enterprise.

From the above stories, we note that holistic science and technologies are reminiscent of indigenous traditional knowledge and practices where individuals control the process of their own work from beginning to finish. When they make situational decisions as the work proceeds, control is theirs. The products and/or outcome of their work are unique, based on decisions that only they can make while they engage in their daily discourse and/or work. They draw upon their own experience, each time applying it to the demands of each situation. Using holistic scientific and/or technological knowledge does not imply that people do not work together. There are collaborative efforts involved but these mesh together in such ways that each individual is in control of a particular process of his or her engagement. What the elders bring to our attention is that the advent of modern science and technology has promoted a shift away from their holistic and outcome-based science and technologies to specialization by process which is very prescriptive in character.

The scientific need for precision, prescription, prediction and control provides the framer with little latitude for judgment in contrast to what happens in holistic planning, organizing and doing. The prescriptions by others narrow down and define what is right beforehand. The sequential organization of work into separate executable steps moves the power of control to the organizer, the boss. The whole process itself is prescribed with sufficient precision to facilitate the dovetailing of preceding and following steps. Adoption of this design to knowledge production and the pursuit of daily living acculturates one into a milieu which legitimizes external control and internal compliance. In this way homogenization and narrowing of thinking, defining, interpreting, and acting take place.

The elders alert us to the fact that this form of acculturation of traditional communities into isolated tasks and the associated prescriptive work processes in pursuit of 'development' is a formative factor which locates a social and political thought and behavior, bureaucratization in its all-encompassing forms. The examples the elders shared indicate that it is already prevalent in administrative and economic activities. Granted that these prescriptive activities are effective and efficient in their own terms, they come with an enormous cost: a social, cultural and ecological mortgage which means that indigenous communities live in a culture of compliance, that they are ever more conditioned to accept orthodoxy as normal, and to accept that there is only one way of doing things.

In emphasizing the difference between holistic and prescriptive organization based on scientific epistemology[12], the elders' narratives show the importance of the need to understand the ways in which those prescriptive framings fragment work. By splitting a single task previously done by an individual into several tasks for a number of persons, some basic parameters change: latitude for judgment, decision-making, working in collaborative endeavors are inhibited and they are acculturated to external control, authority, and conformity. The planning processes that have fostered the development and the spread of science and technology have also fostered an evolution of infrastructures that we now take as a given, normal, and unquestionable part of our reality. With a capitalist orientation, planning and resources have tended to provide the infrastructures necessary for the expansion of new technologies, advanced scientific knowledge — all for higher production, more wealth through the diffusion and use of the products of modernization

The process of cultural transformation among indigenous groups arising from scientific and technological prescriptions is also illustrative. The elders' example of the introduction of the fertilizer-responsive hybrid maize by the Ministry of Agriculture into a traditional culture is insightful. From a mechanistic, scientific perspective, this was seen simply as an additional technical option among those available to rural farming communities. The old maize varieties are presumed always to exist. Instead of recognizing that the adoption of the fertilizer-responsive maize will depend on social organization and cultural values, the mechanistic worldview does not foresee that the adoption of the new maize will select in favor of the form of social organization that is most favorable for it. The purchase of fertilizer, for example, favors those farmers who would plant for the market as compared to those who plant for subsistence, making the 'shift' to the new form of maize a process which favors market social organization and the supporting individualist values.

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[12] *Epistemology is the theory of knowledge (Simmons, 1993). The disciplinary nature of science and scientific discourse fits this notion of epistemology, for science seeks to define, differentiate its principle varieties, identify its sources, and place limits to what science is. The elders' narratives exposed me to a different concept of epistemology: more in the perspective attributed to Bateson (Harris-Jones, 1995). To the elders, (epistemology) knowledge and its application is a form of bridge between the spheres of intellectual, emotional, observational, theoretical, and even spiritual experience. When this is extended to capture reciprocity with nature, as upheld by the elders, then we have a framework of an epistemology for an ecoscience visioned in this inquiry.*

In this study I was interested in exploring how the usefulness of indigenous scientific and technological knowledge to traditional peoples has been met with some strategies for its protection and promotion, systematization and discrimination within the formal educational sector, with specific reference to Makerere University. One of the persons to whom I raised this question was Lawino, a student in the Adult Education program at Makerere University. Lawino works with non-government organizations on rural development and food-aid programs. She observed that:

> The first thing I would like to say is that I hope you scientists appreciate that the rural people are scientists themselves. If you look at the way they live, and that they manage to live in the condition they are in, they are actually a people who have managed to harness nature to some extent for their coexistence. And you will also appreciate the fact that these are people who are harnessing nature with some form of inborn instincts. They are not using knowledge that is external to them - they are using some form of knowledge, instinct, in a spontaneous way to survive. So to me, this is more of a scientific life than the one which you read in the textbook.

In her response, Lawino presents a view of the indigenous system of knowledge which is comprised of complex activities, based on implicit scientific principles. She also affirms that indigenous knowledge in general is owned by the people Lawino's remark appeared to establish a distinction between indigenous knowledge and the formal school book knowledge, with the former having a vitality from its contextual and deep implication in people's lives. In contrast, Olupot (1995) writing on Intellectual Dependency convincingly points out how the book-based knowledge as we have it in Uganda is not locally constructed but imported from the West. What are the possible functional similarities or differences between indigenous and formal-school (or Western) knowledge systems? How scientific is indigenous knowledge?

Beba, a professor of Pathology, Medical School, Makerere University who has studied Human Anatomy and Physiology extensively, in relation to people's traditional practices, spared me a few minutes to provide some insights:

> Look at our societies in Uganda. We have to ask ourselves some questions: What are our traditional dishes for sources of sugars, starch, vitamins, proteins, minerals and roughage? How did we come to select these as edible? How was the whole combination arrived at?
>
> At what stage of our ancestral development did our fore parents decide that these things were edible and that others are not? How did they determine that these were all that were complete for good health? Who discouraged them from trying out the other things that we now know through our so called advanced science as harmful to health? How did they determine which varieties of cassava are poisonous? How did they get to know how to prepare the poisonous strains of cassava in such a way that it was safe for consumption, like in making *Tonto* (potent gin)?
>
> Most importantly, what has our knowledge of school science and technology today added or removed from this list of foods available to our communities to this day? These things were known to these people. No one wrote it for them.
>
> These people had the technology of food selection. Ability to identify from nature what it is that is useful and wholesome for human food. Can we really say that we have more science and technology than these people? Why then do we or should we insist on fabricating our curricula on anything else than anything that has proved bountiful through our history?
>
> Why don't we take interest in some of our science and technology which could perhaps make it easier to optimize our quality of life in our context? We are busy learning about things which are good for people overseas - a totally different setting - and ignore our own.

From Beba's response we are brought to a vision of indigenous knowledge that is scientific in its own right. Beba has highlighted the indisputable ability of indigenous people to selectively isolate, produce or procure various plant-foods, animal, bird, fish products for food and certainly for medicines and other uses. He also expressed disappointment over the way in which Ugandans have pole-vaulted over the functional indigenous system to externally constructed book knowledge.

During my discussion with the Osukuru elders, they made mention of their origin as being Abisinia (Ethiopia), which they locate in the early seventeenth century. Through stories retold to this day of the long and slow progression through different terrain and vegetation, the elders revealed their innate capacity to survive and meet their basic needs gained by experimentation and the accumulation of information about plants, animals, and varying landscapes. On the point of traditional medicine, elder La Patan mentioned that they do have various medicines, including those that have the ability to completely reverse the symptoms of *akuwe* - a hydro-cell (scrotal fluid mass), however big the mass is, without surgery.

> The medicine for a hydro-cell is just by the well in the swamp. I can show you if you want to know what it is. It is so effective that one does not ever need to go to a hospital to remove a hydro-cell by surgery.
>
> Even on this issue of family planning, most families had two to four children at most. We had ways of blocking further production of children by a single dose of a herbal drink by a woman, and without any complications.
>
> We had our own implements for digging, harvesting, hunting. We made them from wood, shaped with stone-edges. We also had metallic implements, but they took a lot of time to make. In fact we are a smelters' clan. That is why we have the name *Etatai* (literally translates into *Technology*). Our digging tools were sharp, and shaped like a shovel. The spears were of different sizes, shapes, and weight depending on use. All these were made from wood and metal

Technical knowledge was variously employed in the construction of shelters, hunting and defense tools, food -storage facilities, fishing, canoeing, farming and food-preparation and eating utensils, water collection and transportation. The elders presented a view of their people who knew how to organize and direct large groups of people to do work collectively. As a people therefore, they manifested an interest and ability in abstract critical thought, empirical verification, lists and perhaps tables of various things without any documentation. Oral histories were made of the long arduous journeys to locate new territories. This needed clear knowledge of direction which the elders reported as being accomplished by knowing various star positions. Expressing a sense of satisfaction and, at the same time, a sense of loss of the old ways of doing things, elder La Patan noted:

> Our local wisdom was good. It served us well. When I look back I miss the old days. You young people should learn to look and reach back in time and space (*Kau*). Your roots. It is your sprout, and source of your very being. Without contact and constant renewal from it, you cannot go very far in any thing; whatever you achieve without this linkage is a bubble.

From the elders of Osukuru, we get an understanding that their traditional knowledge was replete with a supernatural moral code or ethic that governed the interaction between human, natural, and spiritual dimensions. The description of their accomplishments evoked a feeling that indigenous knowledge itself was also based on experimentation on medicines, foods, and indigenous technology. In general, it encompassed a number of general principles and specific rules that regulated human behavior toward each other and towards nature. Notable among these were the production processes that promoted reciprocity, holism, and appropriateness to need.

A contrast between traditional living and ways of doing things with the current times was pointed out by elder Amu in a women's focus group discussion:

> The ever increasing ambitions of our rural people have reduced the proportional significance of food available to us. They have to pay fees to get children to school. people increasingly want bicycles, they want more clothes, shoes, watches, foam mattresses, enamel plates, saucepans, radio cassettes. Dancing and watching video shows in town! Many young people would rather sleep hungry than lack or miss some of these things.

To Amu, the transition into modernization has visibly promoted factionalism between the old ways and a modern lifestyle, implying that tendencies have become more pronounced than when tradition was the controlling factor in community cohesiveness. According to Amu, therefore, modernization has undermined their indigenous knowledge in general by exposing more of their youth to ways which contrast their traditional values. This has created, in their new generation, attitudes that inhibit the acquisition and practice of their local knowledge. While elder Amu's concern focused on the increasing numbers of youth in favor of modernization, among some of the contemporary elders, conversion to Christianity and as well as formal schooling have led to a similar disenchantment with some of the traditional values. An example among the focus group participants was Elder Katan who is a church clergy exemplifies this cumulative shift from traditional norms.

4.4 Environmental Consequences of Modernization

In the Osukuru community of Tororo, the significant manifestation of modernization in their midst was evident in the establishment of the cement, asbestos, fertilizer factories by the Osukuru hills during the period 1955 - 1970. In the early 1960s, a depot which mixed DDT power with a paraffin was also established next to the fertilizer factory. The canned mixture was distributed under the name *dudumaki* to the cotton-growing areas all over Uganda.

After a meal at elder Katan's home, the discussion centered around the impact of these industries on the Osukuru lifestyle and environment. We were washing our hands outside one of the huts overlooking the foothills to the West when elder Katan spoke again:

> Above the main cave you can also see that small section not yet reached by the blasting of the rock for lime, another cave where leopards came every three to four years to cub. They last came in 1984. As you can see, the hills are now bare. The *Isukur* plant is hardly seen any more. Now it is the baboons roaming that place.

> When they (government) established those industries, *Huh* ! There was white dust all over here. The banana plantations lost the green color. Our own skins got itchy, dry and scaly. We coughed. We sneezed. The children could hardly sleep well, always sneezing and coughing, particularly when the wind blew this way. The rainy days were a little fairer.

La Patan added:

> The "mud" (sludge) from the fertilizer industry choked our swamp. The fish died. The water and soil turned red. The huge forest which used to be by the swamp was all cut for the cement factory. Other trees just dried up. Where are trees again? The few up here the men have finished them for charcoal and selling dried wood for food in town and drinking.

Elder Dikko joined in saying:

> That Dudumaki for spraying cotton could smell! Some people like pregnant mothers could fail to eat. I am happy it closed.

These remarks showed a critical element of observation and monitoring among the Osukuru elders of the negative impact of emissions, effluents and production inputs into these factories on their natural environment and the negligible benefits they had reaped from their presence in the community. The rock blasting for example expelled the leopards from their usual breeding grounds in the hill caves. The *Isukur* plant which had been their major famine-time source of food had been destroyed by some of the factories' emissions and or effluents.

I later surveyed the industrial area including the cement, asbestos, the now defunct fertilizer industry, and the surrounding buildings within a kilometer's radius. It was shocking to see the number of houses which still had roofs, water gutters, water tanks, and pipes made from asbestos, despite the alarming evidence, confirmed by modern science of its carcinogenic properties. The safety of children, animals, and birds is at risk from the factory itself which, although non-operational now, has not been effectively sealed to prevent fugitive dispersal of asbestos dust by air and rain water. The combination of the dreadful chemical pollutants in one place and their visible effects was so overwhelming that my research assistant, Kossy, with a feeling of helplessness remarked:

> All the industrialists! All these things we are looking at, Mr. Oluka! Thank God, that the ozone layer issue has opened the eyes of the scientists. They have seen that we can't just leave these things like that because these things can cause real problems elsewhere. We have been having problems with industrialists, but we have never been made aware of these problems. But now the ozone layer is an eye opener. Now we all know if we do not do something, the human race is finished. Because this one there is no discrimination. Rich, poor - there is no way you can get away from it. I

> think with time you people, as you are there now, with time, you will give us the answer. And if we carry out programs of information, education and communication about these concerns at all levels, it would be useful. science must definitely come in now to save us.

Kossy's lament straddles two polar views of science. First is her disappointment over the misapplication of science as an engine of modern human civilization which has brought catastrophe to the ecosystems. Then she exposes the helplessness of people in coping with the ecological tragedy, and with hope in science's dynamism, she invokes science's capacity to reverse some of the pollution caused by industrialization. Modeled on the principle of science, modernization seeks objectivity, control, while focusing on profit which demands some elements of detachment from effects or feelings for nature. Evernden (1985) describes a typical form of detachment found in 'objective' pursuits when he quotes an early nineteenth century scientist: "A physiologist is not a man of fashion, he is a man of science, absorbed by the scientific idea which he pursues: he no longer hears the cry of animals, he no longer sees the blood that flows, he sees only his idea and perceives only organisms concealing problems which he intends to solve." (pp. 16-17). Similarly modernization, as is evident with the Osukuru community, was pursued by people who cared not at all for reciprocity between people and ecosystems. On the contrary, ineffectiveness and insensitivity to those concerned was pointed out. Kossy gave an example of the Forestry Department in the district:

> Those forestry men are very useless. I am telling you the truth. They are there sitting in offices from Monday up to Friday and never move out to see what is happening in the country-side. Why don't they go out to mobilize people to plant trees and discourage tree cutting? We have these Local village governing Councils (LCs) who are alert and young. Why are they not mobilized to encourage every home to plant some trees? After all each LC unit is responsible for only nine households - mobilization is feasible; and tree planting can easily be achieved. Monitoring is also easy.
>
> The tree planting can be done in gardens or all around homes. With these many homes all over the place, the effect would be visible. The cushions of trees everywhere is a very attractive one.
> I think the same can be said about agriculturists (as of Foresters).
> The agriculturists teach about spraying of food so that the yield is so (good). Do the agriculturists stop and say: *After spraying those chemicals, where do they go?* Don't they enter the food chain? I do not know what they are doing in those offices.

In spite of their being paid to promote activities that could help save the environment, Kossy's description of the attitudes and behaviors of the Forestry and Agricultural officers is that of insensitivity to forest conservation. In the forthcoming sections, we will encounter an observation made by an ecology graduate student at Makerere University who reinforces Kossy's about Forestry graduates. This indicates the need for science and scientifically based professionals to build an ethic of responsibility and accountability based on an alternative paradigm of professionalism and standards of practice. The scope and framework of such a paradigm may require the engagement of what Hoyle and John (1995) call a "voluntaristic commitment to ... principles governing good practice, and the realization of these through day-to-day professional activities." (p. 104); or what the United States Vice President Al Gore (1992), writing on ecology and human spirit, calls self-stewardship.

Through her observations and interactions with the Osukuru women, Kossy clarified some views of the women's focus group discussion about the gravity of deforestation and the concomitant desperate energy needs of the Osukuru people:

> A poor environment definitely goes towards making people's lives very miserable. This is a huge problem. Where are the trees? And the women in the village face it more than we do here in the school compound. We don't know! In the village there! Each time when they come to see me here, they look at the hedge-plant which we have here and say: *My! You have a lot of firewood!* At their homes you do not see such things. They use raw sticks! Who can leave wood sticks as firewood to dry? There is no time to make it dry! I asked one lady participant: *How do you manage?* She said: *When you dig out your cassava, the stems (are strictly yours!). No one can step in your garden like those days when the stems would be there then any child would go and collect. Not anymore. Now it is just like food also. You just can't go to someone's garden and pick the cassava sticks. That is not the end of the story. After uprooting the cassava, one has to get a panga (machete) and shave off the buds.*

Kossy provided the women's explanation about why the buds have to be shaven-off:

> That is how they get the sticks to dry. With the buds on, the cassava sticks never dry however much they are exposed to the sun. I did not know that. Eh! That is how it is. You cut off the buds, and you throw the wood to the sun. In two days your sticks are able to provide fuel. That is science, isn't it? A science, technology - by the rural person - which we (the educated) are not aware of. They have discovered by themselves that: We can provide ourselves with more firewood if we can make this cassava stems dry faster. But how do we do it? This thing does not dry! Another thing, this white-sapped hedge-plant behaves like the cassava sticks. If you cut it and leave it just lying there under the sun it will take at least three to four months before it is useful woodfuel. But if the bark is removed, within three days, Mr. Oluka, that thing can provide woodfuel. That is technology. No one has taught these women, but intuition and hard life has made it possible for them to discover.

This is an explanation indicative of how scientific knowledge and technological innovation is not limited to laboratories, nor is it a singular monopoly of the schooled. Dikko's earlier remarks about smoky roofs reinforces the indigenous communities' own forms of observation and experimentation. The high levels of deprivation of woodfuel described above indicate the seriousness of environmental and related social crisis attributable to the various changes in the socio-economic frameworks in Uganda, more so in Tororo itself. Kossy and the women's focus group have shown that with modernization, industrialization, and schooling based on an imported knowledge system, traditional communities like Osukuru are continually experiencing disharmony as the example of basic energy needs for cooking portrays. Part of the problem seems to be the incongruency of imposed knowledge, organizational and economic systems, values, and practices in the name of "development". This has meant that the traditionally reliable socialization process is no longer a satisfactory device for preparing people to live together in their natural resource bases under the new competitive model promoted by modernization. Instead, the utility of natural resources like woodfuel has been redefined and practically driven by forces outside of indigenous communities' influence and collective interest. In Appendix B2, we see an example of a lime cottage industry which not only uses large quantities of wood but also releases toxic dust to the environment. Another example of this commercialized use of natural resources is the cutting and selling of trees as fuelwood or charcoal. These examples illustrate that behaviors and practices appropriate to particular roles have had to change as the nature of the roles themselves have changed or shifted. The shift from an indigenous Teso people's perspective of nature's resources to the consumerist model is, in the eyes of the elders, socially and ecologically harmful.

4.5 Schooling and Attitude Polarization

Rejection and invalidation of traditional ways through the ridicule of people who cling to "old ways" was one aspect of alienation described by the elders. At Makerere University, for example, students have a reputation for hurling intimidating remarks at village people. Lawino, an Adult Education student at Makerere lamented this practice saying:

> Students of Makerere University here, including those who have graduated scold the people back home and anyone not of university level of education calling them names: *'these villagers'; 'murrum';* elders are called 'matures.' Girls of lower educational status are labeled by university male students *'Michael Wests.'* Who are these villagers or Michael Wests? These are your fathers, mothers, sisters, brothers and people who are engaged in production which keeps this country alive in spite of its problems.

Lawino was clearly irked by the derogatory ways in which the Makerere treat non-university educated people and the rural folk. Lawino therefore deplores the baseless arrogance of the university students. Their view of the majority who are unlike them educationally denigrates a powerful contribution the masses make in taxes and food production for example. In such irresponsible behavior, Lawino sees Makerere University students as blinded to how the university for example, is wholly supported by the very majorities they abuse. Lawino reveals a deep and critical awareness of the ideological and social dislocation framed and perpetuated by the general schooling, pedagogy and relations. Earlier, elder La Patan had made similar remarks about arrogance among some of the schooled against rural life and its people:

> *Nu'ngor-kalu kiliok da kedautu esomero, duc aimuarit*[13] *Kau. Icie mam ekotosi ajenun iuriak kec ko Kau da.*
> Both the female and male youth have now a strong tendency not to be associated with us in the traditional life activities. Some do not even want to be identified with parents in the village.

The metaphor of "spitting-out" is traditionally used when there is a strong dislike of something or someone to a point of expulsion from the self. Although traditionally a rare occurrence, elder La Patan has used it here to describe the behavior of some educated people towards indigenous patterns of living. We will later encounter a reference by a science academic to the indigenous knowledge. The statements by Lawino and elder La Patan reveal what Fine (1987, 1990) and Walsh (1991) consider to be cultural disconnection of students, educators and curriculum from community life. Such institutionalized alienation of the educated from the beliefs and concerns of the majority of cultural communities manifests itself in the ways with which the educated perceive and/or seek to solve the needs of the peasantry class, as Lawino continued to relate:

> What would a peasant ask for? Perhaps that his son should be able to go to the nearby primary school and has a pen and some exercise books to write; his cassava is doing well in the gardens as well available in stock; during Christmas he is able to buy new clothing for everyone in his family and eat something nice and special; this is about it. But if you went into that village the first thing you would want to transform could be: people having iron-roofed houses, have piped water around, large roads going to the trading center. You see the difference? Unless you begin to perceive that, you are not being supportive of these people. I have witnessed development organizations demanding that these poor people walk long distances to the nearest trading center or school building with iron roof just to hold a meeting, yet these people hold their meetings under trees; or they could hold

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[13] *"Aimuarit" literally means to "spit out," which connotes, in social relations, a deep-rooted dislike.*

> a meeting in a neighbor's home. We think meetings should occur in a *big and nice-looking* place. For them anything can do, and the things you are going to discuss can be discussed under that tree.

In this response, Lawino alerts us of the deeply embedded view held by the formally educated that the rural majority need modernization in both material and organizational terms. Albeit in a subtle way, for example when she points out how village people meet under a tree, Lawino is letting us know how rural people still live in concert with the land, and have learnt their place in it. With a modernization mindset, Lawino sees the formally educated, including development organizations, taking a confrontational and an ideologically intrusive stance in their efforts to "develop" the people and their land.

Such arguments for modernization are normally that of "developing" the land and moving humanity toward potentials that are unconstrained by native beliefs (Capra, 1982; Elgin, 1993; Knudtson and Suzuki, 1992). This as a vision of reality that seeks to use modern science, technology and the economic resourcefulness of nature to harness, modify and refine the world to its own ends. Lawino's response, while it clearly identifies the economic, political, social and cultural aspects of the rural - "developer" conflict, exposes a religious conflict as well. The philosophy of life pushed by national development goals and its agents seem to tell rural people that humanity is separate from the Earth. Coming from a position of government authority, this obscures or tends to override people's understanding of their common destiny and renders them vulnerable to ecological catastrophe. What Lawino and elder La Patan urge is an expanded understanding of the capacity of traditional cultures to be the best stewards of their own destiny, a recognition that now needs to accord the rural majorities a role of partnership in determining what is best for them. It is evident from Lawino's observation that modernization, under the agency of state power, feels itself called upon to "develop" traditional cultures, refine the physical environment and create civilization. In effect, modernization is tantamount to the imposition of human order upon the natural environment. In its arguments for refinement and improvement through 'creation of wealth' which is hoped to, but does not, trickle down to benefit all (Toh & Cawagas, 1989), modernization as a world view and framework for living is increasingly being associated with the global situation of cultural alienation, poverty, and ecological crisis (Shiva, 1992; Merchant, 1980; Redclift, 1984).

During this study's workshop in Tororo, participants expressed similar views about modernization: "We are no longer in our natural world" (Mzee: an elder and educator). "We are no longer just killing the single animal we need for today's food. Sparing something for us and other people to access tomorrow is no longer a consideration"

(Mamai: science high school teacher). Kossy, my research assistant, shared a view of the Osukuru women's focus group:

> There is no limit of satisfaction to the wants of the modern man. He wants to get more of everything. He has so much greed that if he cuts a tree today for charcoal and sold it for money, he would like to cut more before another person comes to cut a bigger tree than himself.

In the workshop, Mzee, the only elder who participated in the joint workshop with university academics, alluded to how the pressures of the market economy have withered the will and wrested the control of traditional rural communities of their destiny in their natural environment when he remarked:

> You find that a rural person these days is forced to destroy what is left of the natural environment unconsciously or consciously for survival. My observation of the changing patterns of rural life in the last decades shows that people have no choice but to live on whatever is left on the bare ground.

The tone and message of these reflections is that the trend of activities and behaviors among the rural majorities, as mediated by modernization, have created an inflection on the coexistence between indigenous traditional living and the natural environment. Mamai, a high school science teacher of Tororo Girls' School illuminated the problem further by narrating the following story:

> Like all animals, a monkey has love for her child. I read in some magazine about an experiment whereby both a mother-monkey and her kid were placed in a drum from which neither could jump out. Then water was slowly introduced into the drum to flood it. The mother-monkey kept on lifting the child off the rising water level - lest it drowns. When it came to the point the water level reached her neck, the mother monkey put the child down into the water, stepped on it and jumped out of the drum to save herself: sacrificing her kid in the process. I think this is where we are at the moment in this country; it is survival right now which is bringing this.

To Mamai, it is now a question of survival. In his narrative, survival had a connotation of marginal living, that desperate swing of events to avert death illustrated by the mother-monkey's surrender of the love of her kid, sacrificing it so she can escape imminent drowning. The natural and spontaneous nurturance between humanity and the natural ecosystems -- epitomized here by the mother monkey and her child -- is now portrayed in this story as plagued by civilization: the drum filling-up with water. This is one of those narratives where a participant talked in images.

There is no doubt that much of the hope of Ugandans is invested in science and technology as means for attaining modernization. But a number of questions need to be asked in relation to Mamai's' fable of the mother monkey and her baby. Are educators aware that some drum may be filling? Which drum could be flooding? What and or who is under threat in this flood of science and technology? How should science and technology be constructed in the Ugandan context in ways to give intelligence to the social, economic and ecological problems we face today? I sought views from Amooti, a science specialist, curriculum developer and policy formulator in the Ministry of Education in Uganda. Showing concern himself, he observed that:

> We have come from villages, you and I; and then we went to some educational centers. In my case it was to schools primarily run by missionaries. The set-up in these schools was such that we were isolated from our traditional communities.
>
> Mwiri college, for example was set up isolated on top of a hill, where local people never used to go. Makerere University is also on top of a hill. So to do what we now call science, we had to climb these hills, sat and learnt it on those hills. Now, as you raise these questions, we should begin to say: *Look, the science we are doing ought to have been done about us, with us, and for us and the things that surround us in our localities.* It was not done for us. Now we should begin to search for how it should be done in the village to assist us to stay there. It should also be about our own people taught in daily life. This way, what the people do, or have done before should be recognized and brought to life. It may be some scientific, technological or environmental conception and innovation. Perhaps by our current thinking it may not even be seen as science or technology. But it should not deter us.

There was an expression of deep concern on Amooti's face and voice when he gave this response. In his view, the whole concept of schooling in Uganda, right from its outset as designed by missionaries during the early part of the nineteenth century, deliberately isolated the school-going children from their communities. This separation intentionally served to alienate the students socially and culturally from their traditional heritage. Amooti is also pointing out in his response that the science in Ugandan schools is not founded on the socially defined epistemes and concerns of Ugandans. He also identifies the need to exhort interest among educators to engage in reclaiming aspects of science, technology and environmental conceptions and practice to embody the cultural milieu as a fundamental project that could anchor science, technology and progress on a (Ugandan) human scale. His basis for this call was:

> Our girls in the olden days are known to have been able to soften animal skins to suit making of clothing, bedding, sandals, musical instruments, ropes, pouches, water containers and others. That is technology. These people were making use of what is available to them. We would have loved our science and technology in our educational system to help us improve our situation as we see fitting in our context. Before formal schooling, our

> people could work iron from iron ore as well as make many iron implements. Now having attended our formal education and its science and technology, we no longer have our hoes made from age-old smelting of iron ore. So what has this formal science and technology in school done for us? It certainly made us lose our technology. We are dependent on what we have been taught to accept western science and technology.

Amooti was expressing fear for increasing reliance, compliance and surrender to a doctrine of science and technology which is not organically linked to Ugandans. Accordingly, Amooti voiced a concern for the future:

> Soon we shall be buying the plastic hoes like we are buying plastic everything - the metallic ones were more efficient and robust. Some of our own technologies, like music, medicinal plants, and others, have also been stolen and patented by most of these foreign firms. Ironically, for us to later import. I believe this because some of what we now buy is not different from what we used to have way back in our villages. So when we talk about popularizing science and technology, we should with concern ask whose science and technology we are actually thinking of popularizing. Is it the foreign text-book science and technology, or is it the one which has been suppressed? There are many Ugandans now who will lay claim to being conversant with this modern science and technology. We have to ask what and who they have benefited.

Amooti is emphasizing his point of view that indigenous science and technology need to be built upon. He bases his recommendation on the well-known dependence of many African states, including Uganda, on imported technology, part of which Amooti feels was cannibalized by some industrial networks abroad and re-exported to us. Amooti's concerns for technological dependence by poor nations like Uganda is supported by a number of scholars. Stewart (1995) for example critically discusses social impacts of globalization and marketization, convincingly pointing out that while globalization has created new enrichment opportunities for some areas and sections of society, it has also harshly affected, manipulated or completely left out many others. Such globalization, even in Amooti's interpretation, has involved among others, technology and ideas.

The Osukuru elders asked me to share with them what the state of the environment in the West is like. I briefly talked about the cities, the farms, the conveniences accorded by technology in transportation, telecommunication, health care and abundance of food in the stores which I pointed out as the White people's granary, and showed some of the pictures I took in several places in the city of Edmonton, Alberta, and at the Rocky Mountains. They enjoyed these very much, calling the place very beautiful. I also made references to inequalities of wealth distribution, the presence of the marginalized peoples who barely survive, and of the pollution in the rivers, cancer problems due to environmental toxicity, and the thinning of the ozone layer. Elder Dikko and elder La Patan remarked:

> *Enyalakin teni akwap abeit. Dododo aibe ai?* (Dikko)
> *Ibala bo sio ebe kede aijen kimusugun elai ngina cut pio pio! Mam amunaasi needa! Abeit, arai kijotoor oni, kiwolio.* (La Patan)
> Then this world is a really stirred-up place. Where shall we go? (Dikko)
> We have been thinking that with their wisdom (Read: science and technology) life in the industrialized nations is perfect! That mentality and problem has come up here too! If we do not awaken, we perish. (La Patan)

The sensitivity to the changes wrought by civilization on the earth and to its peoples is evident from the remarks by the Osukuru elders. They responded with alarm to my description of environmental pollution in some cities, rivers, and to the drug-related problems, urban poverty and violence existing in many industrialized nations. They were able to relate my descriptions of problems of modernization with the trend of similar events they have seen emerging in Uganda. These elders ,and Amooti, therefore voice a common call for a reversal which should involve a demystification and demoralization of elite-oriented science and technology and of rural education at all levels, the power to change being squarely placed in the responsibility of Ugandans. Their voices epitomize a deep uneasiness about the future, sensing that our civilization may be running out of time.

Amooti also advanced his opinion on how formal education has been a process of legitimization of this hegemony:

> Looking at our own education system here in Uganda, my concern springs from a fact that from every one hundred secondary school students in the ordinary level program, thirty get into advanced level; this leaves out seventy, the majority of which may resettle in villages. How much of the school science and technology will our education have given them to operate productively when they return to the village activities? Among the thirty that get to the advanced level, Makerere university and other higher institutions of learning may take twelve and the other eighteen facing a similar fate as their counter parts who were left out after the ordinary level and for whom we should raise the same question.
>
> Of that proportion that gets to Makerere University, say in the science faculty, there is even a more critical question as to whose science and value systems they are prepared for in their university education. How much science and technology will they be carrying to improve the quality of life of the majority of the people and the environment from which these people eke a living? How much benefit will they have made on the way science and technology are used in the communities and their concerns in Uganda?

Using this personal experience in curriculum development and the frequent meetings with the Uganda National Examination Board (UNEB), Amooti is fielding a perennial educational problem in Uganda: The pyramidal structure of educational access, characterized by high drop-out rate, when combined with a curriculum that has not been formulated on the basis of national concerns is, to Amooti, a cause for poor utility of school science and technology in the broader Ugandan contexts. Amooti therefore, challenges educators and all sympathetic to the social and ecological plight in Uganda with questions that need to be confronted with honesty and reflection, in order to begin searching for paths into transformation that are socio-culturally sensitive. In ecologically embedded framings of science, one cannot begin to ask and critically inquire into these questions unless one shares views, meanings and concerns about indigenous science and technology, as Amooti pointed out:

> Definitely I think every curriculum must ask of itself these questions. I know we must definitely posses something in industrial chemistry in our so called formal sector; but we must also look at the industry of the majority out there in our communities. Their industry may not be classifiable by our unrealistic criteria of chemical, physical or biological; but it is an industry of some kind and it has over time worked with our people. It could be agronomy- applying better mulch, natural manure, better protection of soil from erosion and so on. I think these are some of the things that should be concerning us.

Amooti's line of argument is that technology and related sciences that were introduced to Ugandans have tended to pull them away from the villages, with education playing the role of a socializing medium into realities that are not culturally embedded to Ugandans. He views the deteriorating environmental quality as sending signals which need to be seen as an opportunity for redirecting thought, planning and actions towards environmental preservation in ways free of the Cartesian spell under whose influence modern civilization has shown little connection between the routine banal acts and their moral consequences. Amooti has also argued that Ugandans may not sustainably make a living in a failing ecosystem in spite of possibilities of remedial technologies surfacing in the foreseeable future. It is a plausible argument in the sense that Uganda is a poor country. Possibilities for availing advanced scientific knowledge and technology to manage a dilapidated environment, should such knowledge and devices appear in years to come, may not be afforded and distributed in Uganda in any sustainable, just and equitable fashion. A logical approach is therefore to pursue frameworks at this time that may empower people with what they already have culturally and before the natural environment depletes irreversibly.

The complexity of the problem of alienation arising from modernization in the wider educational context is further alluded by Loma Bon, a university professor in sociology:

> I feel our education is not in our interest. It has a foreign agenda. It creates and enhances the disparity between the educated and the rural people; the former considering the latter unimportant because the latter lack education. The ridicule of the educated (learned) for the non-learned. This has come to a point that there is a permanent view of negativeness and poor communication between the two polarities.

> Personally I feel that it is us the learned who create this negative feeling for the unlearned. We also fail in bringing the awareness about the state of the environment to the communities; and when a learned person does go out to these communities, we never show any form emotional concern over their life and what they value or go through, and the rural communities are aware of this insensitivity which the learned have towards them. In the face of the environmental problems now faced by these communities every where, this stereo-typed perception creates serious communication barriers.
>
> If we consider the human race as part of the environment, how can we love and value nature to which we are part if we do not love and value one another? This is also a contributing factor in the erosion of that emotional bonding for people and the environment. If I can come and cut all your trees and leave mine intact, I win over you - least concerned about what you go through.

According to Loma Bon, to maintain their hold on the indigenous rural communities, the elite have made sure that basic decisions affecting such villages are made from outside such communities. For generations, if the villager had been allowed to show any initiative at all, it has been only in very limited areas. In their presumably paternalistic approach to educating and civilizing the Ugandan society, Loma Bon discerns that the educated have betrayed the very purpose and meaning of education. As noted by Loma Bon, the elders at Osukuru also expressed similar comments regarding the indifference of the elite to community problems. They mentioned how government authorities in various sectors like agriculture and local government always organized them on the basis of oppression and coercion -- often violently. Elder La Patan, conceding to the dominating nature of the elite in power positions as an immutable state of affairs, said:

> The orders, levies, restrictions, taxation just keep coming like the rain from above . At least to the Heavens we can implore but with these people (authorities) it will take a miracle. They cheat and harass us all the time and get away with it. To whom can we go? Huh!

This statement was made with a facial expression and a series of shrugging of shoulders which displayed utter helplessness and surrender. To me it became intensely apparent that these elders have been witness to and or subjects of victimization, humiliation, exploitation and manipulation by persons in the state machinery, possibly since the onset of governance. The elders considered the hierarchical management of people's affairs which has so influenced the way in which they relate to each other and to the natural environment as so serious, that they portrayed a view of our civilization as, in some basic way, dysfunctional. In the paradigm of the dysfunctional family, the rules are simultaneously unreasonable and immune to questioning and can perpetuate disorders like child abuse and many forms of depression (Liang, 1972; Bowen, 1978; Bradshaw, 1988). In a similar framework, we could relate to the elders' perception of authoritarianism of centralized management and the definition of civilization as dysfunctional because they are not allowed to question the rules. Liang, Bowen and Bradshaw point out that rules go unquestioned in dysfunctional families, making children so dependent that they cannot afford to notice a problem with the parent, or notice whether the rules make sense. This seems to be the kind of dilemma the elders find themselves in relation to the driving forces of modernization and the looming ecocrisis.

4.6 Population, Gender and Environment

The problems associated with the dislocation of indigenous knowledge and the rapid decay of the environmental systems are not limited to education and modernization. Other sources of pessimism among the study participants about the future are the concern over accelerating environmental degradation and the long term sustainability of agricultural productivity due to high population growth, and the structural injustices and violence impacting on the environment. Further discussions with study participants from Tororo and Makerere University exposed awareness and concerns that in Uganda, a response to this challenge must become a new central organizing principle. Kossy, my research assistant and a geography teacher from Tororo Girls' School observed that:

> An increasing number of helpless people is seeing the environment as the only means to survival. Many people in this situation will certainly cut down a tree for making charcoal or selling it chopped as fuelwood; or encroach on wetlands if he has the chance. In particular with the rural majority and the urban poor, you will find the desperation is so urgent that they do not even have the time to realize that they are destroying the environment: whatever it is they are doing, it is just a matter of doing whatever it takes to survive. Population explosion is a factor which we should recognize as having contributed to the erosion of this love for people and the environment.
>
> There is also the ignorance element: not being aware of what consequences their actions are having on the environment. This couples with the general lack of options to coping mechanisms in their plight of poverty.

To Kossy, continued extractive dependence on whatever is left in a depleted environment among the poor is a question of survival with whatever the ecosystem has to offer. Her submission of the helplessness of the poor in making the most of whatever is available on the ecosystems to make a living was corroborated by Lugga, a professor of biochemistry at Makerere University, when he shared this view on the current plight of the people and their helplessness:

> You can lecture to the rural people up to the end of the century but if they do not have their basic minimum needs, they wont think about the environment. That is not their priority. In my interpretation, people in the traditional sector are responding to their basic needs: economic needs at the moment. If you go tell them that next century this will all be a semi-desert. They will not even understand what you are talking about. Even if they do, I believe they will say: *We have to eat.*.

Lugga lucidly presents the dilemma of an environmental conservation drive among an impoverished people. Besides his acknowledgment of the insufficiency of education in reversing the trend and state of affairs, Lugga exposes the need for a multi-sectoral approach:

> You see generally discussing education in a vacuum without a social, economic and cultural context does not mean much. No education happens without these. Education is taking place in a real society with real constraints, real limitations and real capacities. Now, if we simply have education, the best education in the world on environment, on technology; on science, does that mean that by teaching about environment conservation and what have you - right from primary school and all the children learning about the environment, all a disadvantages of deforestation etc. - that they stop cutting trees automatically just like that because they're being "educated"? I do not believe that. They have real demands on them: social, economic, cultural.

Lugga continued to provide an example:

> If a child has gone to primary school completed primary school and has learned all this stuff, the next day his mother, or grandfather is dying. They need some money for this or the other. There is an opportunity to make charcoal, you think they desist from making charcoal? That's the scenario, I just want to make a point. To many in similar circumstances I suppose that is an only option. Well, I don't think education alone is going to change very much on that. You may have some effect. I am not saying it will have zero effect. But certainly not much effect. You must present the social and economic aspect. These have to be considered.

Lugga raises a fundamental issue related to the ineffectiveness of education particularly as it is currently framed in Uganda on the basis of disciplines. In his view, the insufficiency of education to bail Ugandans out of the quagmire of poverty and ecological crisis needs to be retrospectively blamed on larger factors. He draws to our attention that the all-out effort to save the environment will require deeper respect on the part of government for the political and economic freedom and rights of individuals. Lugga also notes that dramatic measures will be required to ensure that individuals and communities are given both the information to comprehend the enormity of the challenge and adequate political and economic empowerment to be true stewards of the places where they live and work.

Mzee, a well traveled and respected elder in the whole of Tororo community, deepened Lugga's and Kossy's analysis by elucidating that:

> The rural person is destroying the environment ignorantly because of the felt needs of survival.
> When we move off from this simple person to the middle class which has knowledge, they are aware of the destruction they are inflicting on the environment. Look at teachers with a dismal income of UShs. 30,000.00 ($30.00) a month, yet the minimum for basic needs for a month is at least UShs. 600,000.00 ($600.00) for a single person. Because most middle class people cannot afford electricity bills for example, they are depending on fuelwood or charcoal because that is what they can afford, even then, barely.
>
> Then there is the upper class, among whom are the policy makers and implementors of anti-deforestation policies, for example. When they stop you and I from cutting a tree, they are the ones who, for example, buy these electric or fossil-fueled wood-saws. These are the people who do the worst damage in a short time because they have the technology, the cover of power, and the money. They stop others while they do it; and they do it irreplaceably. So the people in the village, the middle class, the top class - all are participants in environmental damage - ignorantly or knowingly, but doing nothing about it.
>
> The rich people destroy the environment to make more money. Because these rich men and women build skyscrapers, they get and feel detached from the environment: they are so detached from it. These are the men who use others to do the "dirty" work out there for them, to make more and more money at the expense of environmental quality. Ironically, they talk about the environment but never practice its conservation.

Mzee sees not only the poor involved in the pillaging of the ecosystems. He also sees the already well affluent individuals equally or probably more extractive on the environmental resources to feed their consumer-high appetites, greed, and the unquenchable expansion of wealth, power for the domination of the weaker people and nature. This pressure on the natural resource base exerted by poverty pressures of the people and the insatiable greed of the rich is exacerbated by the increase in population.

The increase in population density has a corresponding increase in resource demands and environmental stress. To the rural people for whom natural resources are the sole provision for all aspects of living in the modern monetary economy, deforestation, soil erosion and soil-exhausting agricultural practices are inevitable, as Kossy explicitly observed:

> With population growth and poverty in this place, people tend to depend on burning charcoal to sell for cash. Now they are ferrying it across the border to Kenya. Because the market is there. In Kenya you just do not cut trees. They are so strict. Charcoal in Kenya is not easily available. So people here in Tororo are the answer. The forestry people here are only waking up now when things have gone too far and fast. Yet trees cannot grow that fast. But in the villages, what I see is the increase in population mainly. Most men have two wives. Men don't have one wife. Two, three! And he will end up with nine sons, and those sons will have to be given gardens.
>
> A man wants to get as much as possible from a garden. So he will not stand any tree which will put shade around what he has grown. So he cuts it down. What about building material? We no longer have spear grass (used for thatching houses) any more in our place here. If you must get, you must buy (from the now thinly available resource base). It is not seen along the road as I move along the road any more. Spear grass is an indication of land fertility. The fertility of soils have degraded, and can no longer support spear grass. Not only that. No land is left fallow for spear grass to come up and grow, like we used to, in my childhood.

Kossy and the women's focus group enumerated degradation of soils through erosion and crusting as prevalent in the Osukuru and other parts of Tororo district. They also acknowledged that there was no fallowing of land anymore for most families. In a follow-up interview with elder La Patan, he explained that from mid-1960s through to the 1970s, they had been using fertilizers to improve agricultural productivity of the soil, but by the early 1980s, the gardens no longer responded to fertilizer. He also acknowledged that most families could not afford the price of fertilizer. This made farm production the monopoly of the rich, favoring cash-oriented cropping over subsistence farming.

These revelations raised two issues. First, in the ecological context, Tororo district and Osukuru in particular could potentially have more than air pollution and acid deposition mentioned earlier. There could be heavy-metal contamination spectrum of environmental health problems faced by the people. Secondly, commercially distributed fertilizer favored a social organization based on a market economy rather than the traditional peasant form of interdependence.

I had a discussion with the District Population Officer of Tororo. She presented me some statistics from the District, shown in the two Tables below, which support the above observations of the Tororo participants.

Table 1: Some Demographic Data for Tororo

Population (1991)	555,274
Growth rate	2.8%
Population density	238/km^2
Child dependency ratio	45%
Women aged 15-49	23%

From the District Health Officer, Tororo, I accessed the following statistics which are pointers to poor environmental hygiene:

Table 2: Sanitation and Disease Data for Tororo

Water/Sanitation and % of Homes		*Prevalence of some Environmental Diseases*	
Unprotected water sources	70%	Malaria	28%
No Latrines	45%	Acute Respiratory Infection	22%
No bath sheds	43%	Diarrhea	9%
		Worms	9%
		Trauma	5%
		Eye Infection	5%
		Skin Diseases	4.6%
		Anemia/Malnutrition	4.2%

The Tables above illustrate the impact of high population density, averaging 238 people per square kilometer in Tororo, on land resources. The District Population officer pointed out that in the Tororo district, woodfuel consumption as energy constitutes 99% for various household energy needs as a district level average and 100% for rural areas. She also explained that wetland areas in the district are increasingly being drained for commercial rice growing by rural people.

The women's focus group discussion group attributed high population growth to the rising number of early marriages of young girls, polygamy, and a tendency for families to have many children. Kossy gave her reason for girls' acceptance of early marriage and early pregnancies:

> Because she grew in a dark world. She never knew what the world was. Even this raping of young girls by uncouth men can be avoided when girls are made aware. Because they are not aware that these men they are sitting against are weapons. These are bombs! Kids are so naive. They think this is a good person. But this is death! We need to open their eyes so that they know they are sitting next to a bomb.

To Kossy, it is mainly a question of immorality. Being a born-again Christian may be a reason for her focus on this aspect of child-pregnancies. When I interviewed the women focus group participants, they volunteered other reasons. "Many parents encourage, even force young girls to marry early in order to acquire the dowry" (Amu) "It is prestigious to have many children" (Bibi) "To balance the sexes of children. It is painful for a mother not to have at least a boy and a girl among her children. Work at home fails." (Amu). Bibi, being from a polygamous family where she is the first wife, also mentioned that "competition among women in the family, or among clans tends to be a common occurrence." These responses expose the complexity of the problem of population growth, certainly indicating the need for a broad-band policy that recognizes the poverty, labor, individual-family, and cultural reasons and dimensions of the problem. Recent trends of analysis of global events show that success to crisis like population and environment may lie in holistic approaches (Barry, 1988; WCED, 1988; Capra, 1982; Lazlo, 1994). These writings and others point to the need of addressing all critical dimensions simultaneously, with careful attention to how they relate to one another.

Kossy shared her views on how Biology as a science subject can raise awareness about a safe age to have children, by delivering associated facts such as: children delivered by immature mothers; death caused by the delivery; that even if young mothers survive, they may not be able to give birth again. We engaged in dialogue about how through formal schooling, girls can study up to a point that they can make informed choices about marriage and having children. Kossy's view was that after the age of about 25, having 10 children is highly improbable for an average woman. Her reason for girls to mature to at least 25 years of age before marrying was that they would then be alert to survival problems, and likely get employed or be capable of generating income. Similar conditions were seen as suitable for the men.

On how science and science education could be instrumental in this effort, Kossy cited Biology as capable of highlighting aspects of physiological maturation and problems of early pregnancies for girls and the incumbent babies. Physics, Chemistry and Agriculture could address themes like energy, pollution and resource-use, and relate these to population and quality of life. It was the women's view that this model of science education could send a clear and feasible message of population control and environmental resource management without demanding that people limit the number of children they should produce. In her discussions with the women's focus group and in interviews, Kossy raised an indigenous women's perspective of birth control as a measure of confidence by the parents that their offspring will live. Kossy noted from her discussions with the women that once a family has reason to believe that their child or children may die, there is a strong incentive for them to have many children as an insurance to having at least one survivor to grow to adulthood. A higher number of children in a subsistence economy was also expressed as a means of optimizing a support system for water and woodfuel collection, garden labor, livestock care, and other family and clan activities. This view was confirmed when women defined, as part of poverty, "not having *enough* children."

Equally in support of the view that population is a critical factor in the environmental problems in Uganda is Zungu, one of the senior expatriate professors in the Faculty of Science, Makerere University. Zungu happens to be very active in teaching and research within the current environmental programs at the university and at the policy level in the Ministry of Natural Resources. He confidently stated:

> The real problem of environmental degradation is increasing population coupled with people's rising expectations. So the demand of all these people's living causes a massive demand on the resources. One obvious example is the kind of thing where a few decades ago, your grandmothers would collect fuelwood from a local forest patch or wherever there were trees to be found.
>
> But by now grandmothers have got twenty grand-daughters and what was enough fuelwood for a grandmother is not enough for twenty grand-daughters. But traditionally, because these resources were there and were free, the culture is that you just go and collect what there is. In most parts of Uganda there is no culture of planting trees, although it is actually easy to grow trees.
>
> It seems surprisingly difficult to change people's attitude. There are numerous tree-planting programs in Uganda but most of them are actually not successful. I think the success is increasing all the time, but never the less the fact is that at the moment deforestation is happening far faster than reforestation, so there is a net loss of wood for all the purposes that you need wood.

Zungu's analysis identifies as weaknesses both the traditional view of resource use and the failure of the education system to conscientize people about the shortcomings of population explosion, and its resultant impact on the ongoing ecological crisis. What he points out as failure of reforestation programs is later explained by one of the university students as a result of political interference in the identification of target places for reforestation. As pointed out by the elders in the previous sections, during the mid-1950s to late 1960s cotton campaign, there was a wide destruction of forest cover in many locations of the country for cotton growing as a cash crop to bring in foreign exchange for the country. This makes the problem of deforestation more complex than Zungu paints it. Zungu clearly places the challenge to education as one of the key strategies for spreading a network of informed people:

> Schools really have an enormous part to play because that is the easiest way to teach people and not only need to teach them how to do it themselves but to teach them (students) to teach their parents if possible. So as the population increases, you simply have to change your life-style.

These expressed needs for lifestyle changes raises questions about which lifestyle to follow; who makes the choices; and how these changes will be brought about. As pointed out by the Tororo participants, population is an important factor that has contributed to the poor ecological state in the district. They also acknowledge how the poor state of the environment is responsible for people's poor living standards, particularly nutrition. On another plane, population growth and demographics seems to be an area where the growth and production models yield interesting contrasting perspectives. In the last few decades, much has been written and said about population growth in African nations, and the economic depredation, and foreign debt in countries like Uganda (Brown, 1992; Harrison, 1990). At the forefront in this reporting is the World Bank (1992). Unfortunately, it is the growth in numbers of the poor and increasing foreign debt that has captured the fascination of these classical economists and statisticians. It is a serious omission and commission when these studies conspicuously avoid examining the growth in numbers of the rich and the corresponding reflection of the correlation between the growth in these riches and the poor status of the majority of the people in the South nations and of the environment. In Uganda, as in other nations in the Sub-Saharan region, issues related to population growth, resources required to sustain the increasing number of people, quality of life and other related problems have been discussed based on factual data from rigidly developed and defined methodology and or criteria. Of course data on the population forecasts, implications on ecological resource bases available like land for cropping, and the lived experiences of the people themselves add to the reliability of such information. There is, however, a telling absence of demographic data bases for Uganda's growing population of automobiles and expensive housing for the few who occupy power positions.

During discussions with the Osukuru people, the elders explained the contemporary population situation thus:

> It is formal schooling and Christian religion that led to all this mess. Those who went to attend missionary schooling those days essentially cut

> themselves off the traditional ways of living. Christian religion and formal schooling became their only guide. They valued and only learned from the blackboard, reading and writing. That is where there understanding and aspirations remained. They were strictly discouraged from associating with traditional norms. Their marriage was in the church.
>
> They were encouraged to have many children. Children are a gift from God. The young men and women enjoyed that. This was reinforced through baptism, provision of gifts to Christian families. Their children studied free in schools, got jobs in offices. The more children, the more of this glory. That was then. They also benefited traditionally because a family with more daughters for example, got more cows from dowry when the girls married. It became a competition as to who had more children, and how many were in school, how many had jobs. Now where are we? Christianity and formal education is responsible for this.

By elder La Patan's response it would appear that at the onset of formal schooling with its close association with the church, there was a positive feedback between Christianity, schooling and the outcomes of schooling -- jobs, prestige, material wealth -- the long-term effects of which had not been foreseen or marginalized.

La Patan therefore views Christianity and formal education as lacking in ecological awareness due to their emphasis on Christian faith which excluded day-to-day lived realities and uncritical use of resources. In elder La Patan's view, Christianity and formal education led to high population and some of the other social problems due their tendency: (1) to underplay indigenous association of mystical interactions with themselves and nature by labeling these as satanic; (2) toward cultivating individual salvation as opposed to that of the community in its sense of identity and unity with nature; and (3) to use the church and educational bureaucracy to cultivate hierarchical dominance which exerts mastery over the environment both human and natural. In these contexts therefore, Christianity and formal schooling could be seen as socializing people into a view of the world that emphasizes seeing the nonhuman world and people, both individually and in communities, as different from each other.

The women's focus group discussion showed strong opposition to birth control pills as a means to family planning. The elder ladies said:

> A woman after delivering a baby would immediately go and live with her mother-in-law or other elderly lady in the husband's family for at least three years traditionally.
> During this time, she was referred to as "atemonon", and it was taboo for her to sleep with her husband during this time. Clearly this was an excellent and natural birth control method. These days our education has erased this virtuous practice. I hear that a woman and her husband can these days sleep together only after two weeks following delivery. That they deny the child breast milk and feed it with *uuji* (porridge) *Uh huh*!

The aversion of the rural women to modern birth control methods may require further inquiries, and it is not the intention of the study to resolve the debate over which system of birth control is effective. What is apparent is that with colonialism in Uganda also came a number of social services, which besides education, included a health care system, and covered intravenous and or oral immunization against many diseases like polio, tuberculosis, yellow fever and a number of other diseases. With these services have evolved pre- and post-natal care strategies that have reduced the rate of infant morbidity and mortality rates in Uganda, very likely contributing to a higher infant and child survival rate than was probably the case before. A plausible issue is probably the worldview that came with Christianity and formal schooling alluded to earlier by elder La Patan, which tended to encourage an uncritical multiplication and filling of the Earth. As noted earlier, there is a complex meshing of factors under play that dwarfs simplistic analysis to a singular cause.

Structural violence due to the dictatorial power structures mentioned earlier, and the elitist attitudes among the formally educated could explain what the elders of Osukuru claimed as insensitivity to social problems in general, and to population and environmental crisis in particular. Elder Dikko contrasted the state of peace these days to the old days before establishment of Uganda as a state, saying:

> People were happier, worked and related collaboratively. There was a lot of mutual respect, love and caring, unlike these days.

Elder La Patan explained why:

> People now have developed hard-heartedness. There is increasingly no tolerance. Just getting to sit and share a chat, food, or a drink with those who have gone to school, even to lower class levels is impossible. They want to be different from us the uneducated.
> Besides, there is a lot of knowledge about these dangerous chemicals which can be used as poisons. These are known to many of these educated people. It is this schooling which has made the devil *(ajokit)* take abode in people's hearts. In the olden days very bad individuals were unanimously disciplined, even killed, with the approval of the clan *(ateker)*. But these were very rare occurrences. Now the people being killed innocently by bad people are increasing every year, and no one seems to take care of it.

To the Osukuru elders, with education has come intolerance and lovelessness. In their place greed and jealousy, to a point where inequality of possessions by one individual or family makes the others feel lacking, drives people to either catch up or bring the prosperous down to their level by theft, murder, or acts of arson.

Kossy expressed belief in education, noting that the various disciplinary areas of the curriculum when judiciously framed could yield solutions for most of the problems people face. She proposed:

> Integrating, incorporating a few topics in every subject. Do not disturb geography. Do not bring another paper in geography, in biology, or any other subject. No, we do not have the time for it. Just inject a few relevant topics or perspectives at different levels in the already existing syllabus. If this is done successfully through levels. Surely, by the time a child comes out, he or she will be looking at things objectively.

Explaining in which way such a schooled person could display objectivity, she said:

> When such an informed child looks at a chair like this one, she will be able to raise many questions like: *How many people in Tororo here alone have this chair? Where has this wood come from? Did they replace those trees?* The child will be there while disturbed. That is something practical, not dead, theoretical (stuff) for passing the exam. Let the child come out when the child knows: *I have a family; I have not gone very far with education. Perhaps I am a primary school teacher. But I can still live a comfortable life.* In twenty five years' time - we might not be there. But when these young one now meet: the one in the village, the one in Tororo town, the one in Kampala, this form of education could make them all happy.

Sharing on her personal visions of village life, she continued:

> In some of my field work and whenever I go to my people in the village, I see a lot of what we share here. Life is bad for too many people. If you go to the villages just there where we went for field work, the students saw and learnt. We do not have to tell them any more that things are not good. You find dirty children. The parents are not to blame. They do not have soap to wash those clothes. Soap is unaffordable for most villagers. Salt is not there. Education as I told you - these children are not going to school. You think parents are happy that their children are seated at home? At least everybody is aware that their children should go to school. And everyone whose child goes to school feels happy. But for the majority, where is the resource? It is not there. So the children sit back. And to make it worse, perhaps if one had (only) three or four - perhaps one would be able (to live in relative comfort). But now that they have ten, there are ten children per woman here in Tororo. *Eight, ten, twelve children per woman!*

Such lived experiences of the rural people as described above by Kossy paint a true picture of population growth, and the associated struggles to make a living within the ebbing ecosystem base. In the upcoming chapter we will encounter some voices that provide insights on the impact of population growth on environment and living conditions, and the potential role of education that caters to the plight of the majorities to reverse the threatening trend.

4.7 Summary

The findings expressed in this chapter about traditional knowledge of an indigenous community in Tororo demonstrate, at least in historical terms, that the knowledge system of the Teso community in Osukuru encompassed some elements of a reciprocal coexistence with the natural environment, as well as the practical and spiritual relationships of the people to these components. From the narratives and examples of the elders and other associated participants, we have seen that the indigenous knowledge system of the Teso people combined science, technology, and ideology in a closely quilted relationship. The elders have conveyed some conviction of wholesomeness, richness, and the diversity and balance of the foods they obtained through gathering, hunting, fishing and through the abundant yields of farming on the then fertile land, and shown how these activities were facilitated by an integral use of their science and technology in culturally, socially and ecologically sensitive ways.

With the Osukuru experience shared by the elders, it was clear that development cannot take place in isolation. It is much more than the overt acceptance of material and technical extraction and or manufacturing of products. It is an ecological, cultural, social and psychological process as well. They reported that technical changes that have occurred as a result of industrialization in the Osukuru area have come with environmental impact and corresponding change in the attitudes, thoughts, values, beliefs and behavior of the people who are affected by the material change.

We have also encountered elders' and some academics' recollections about the decay of the traditional knowledge base, and the destruction of the environment due to the power of modernization. In the forthcoming chapters, these issues are explored in relation to other forces, both local and international, and in light of the perceived roles of science and technology. What we have heard are some voices on how the rural masses, their culture, values, attitudes and practices, and the fragile and highly interdependent ecological systems within which they co-exist, have been compromised by the encroaching processes of industrial development and urbanization. These processes and outputs of modernization have overpowered the natural balance of their original social and environmental harmony which are precariously balanced within their current environment.

A shift in lifestyle from traditional to competitive cash-based forms of organization, enhanced by educational and government development policies denigrated indigenous living and values. Some consequences of such negative policies, and practices were the alienation of Ugandan youth from traditional cultures in favor of modernization, increased population growth, and mounting pressures on the natural resource base which is the sole basis for survival of the majority. To the Osukuru elders, many like Zungu who seek these sundry indicators of development would be seen as not raising fundamental questions about the implications of pursuits of modernization through uncritical industrialization. These fundamental questions would include: Where are the indicators of development? Whose interests do they serve? Whose interests are not met under these conditions? Why? and What is the overall impact of this development model on Uganda, its people and its environment? In particular, the increasing importation of automobiles to Uganda in the last decade may have solved certain transportation problems. However, when the volume of traffic chokes movement on the streets of Kampala City, and these numbers influence the establishment of special support frameworks for increased imports of fossil fuels and other structures, it is time to pause and rethink priorities and the attendant issues. Such technologies and imports which rely on the use of scarce foreign exchange, often borrowed from the World Bank, benefit only a few at final cost and consequence to the poor majority who must suffer the injustices of heavy taxes and the burdens of cash-cropping. Greenhouse gas emissions from fossil fuels, the toxicity of automobile exhaust, the smog and associated health problems are well known effects of heavy traffic (Caldicott, 1990; Rodricks, 1992; Mackay, 1991). Such considerations need to be weighed against Uganda's resource limitations, and equally important, its urgent need for good health and education for all.

We note great concern among some of the participants over family planning and the need to have a manageable family size through birth control. Legitimate as these concerns are, it is also timely to begin asking whether car-import to Uganda is an equally urgent issue needing control. Family size, life expectancy and food-value statistics are well recorded in many parts of Africa and the world. In this respect therefore, to continually maintain a stance that the poor people are a source of problems because they are "unproductive" and have large families, and that modernization will provide solutions, is shortsighted and potentially destructive. Current circumstances may call for a logical analysis which views cars and huge private houses as cohabitants of this Earth, subject to the equally limiting parameters applied to human populations. While the population factor should not be ignored, there must be consideration for the natural resource consumption. According to the New Internationalist, September 1992, the current consumption ratio per person in the industrialized societies is, on average, 20 times the rate of consumption per person in a developing country. The South's population would have to more than quadruple its numbers to reach 20 billion people before they consume as much as the single billion in the North. In the year 2050, the population of the South nations is expected to double to nine billion people with a corresponding little increase in the North (UNCED, 1991). To cling to the view that the population increase is a dominant factor in environmental degradation, may misrepresent the genesis and subsequent strategies to approaching the problems of the poor South nations like Uganda. It would also leave unchallenged the increasing support and prevalence of the productive model of the dominant educational, economic and sociopolitical discourse of our age which is the brainchild of modernization.

As we will encounter in the subsequent chapters, education which particularly recognizes and promotes the role of women will feature in the views of some participants as one way to redirect efforts towards population stabilization, harmonizing attitudes, goals and practices towards sustainability and reciprocity of people-nature interactions. The role of science and technology in this reshaping of the future for the people and environment relationship is central to the upcoming chapters. Critical questions regarding the perspectives of science and technology vis-à-vis socio-cultural and ecological challenges are reckoned with in the forthcoming chapters.

CHAPTER FIVE

SCIENCE, TECHNOLOGY AND SOCIETY IN EDUCATION

5.0 Introduction

This century has witnessed dramatic transformations in two key factors which define our relationship to the Earth: a sudden and startling increase in human population, as some reflections from previous chapter have shown; and a sudden acceleration of the scientific and technological revolution, which has facilitated an almost unimaginable magnification of power to affect the world around us. The cutting, moving, digging, burning and other forms of physical and chemical exploitation of the Earth have transformed the physical matter that constitutes the ecosphere.

In his study of seventeenth and eighteenth century economic literature, Johnson (1964) forecasted the prevailing opinion among all nations today, particularly those in the South, that the keys to economic progress will be forged in the classroom. This argument extends to the role of the laboratory, the inventor's shop, research institutes, and hence science and technology, in appreciating the crucial importance of this knowledge to economic progress.

In this chapter, we examine the role of science technology in society and the environmental concerns in Uganda, using examples drawn from Makerere University science academics' interpretations of the goals of the science programs in relation to national development. This chapter attempts to highlight issues and problems associated with the academics' perceptions of the theoretical and practical importance of science and technology to Uganda, and how the promotion and incorporation of this knowledge, in concert with some aspects of indigenous knowledge, potentially equip Ugandans to cope locally with social and ecological problems.

The chapter is composed of participant narratives and responses to questions which go beyond the well-known problems and admittedly serious constraints in Ugandan education such as the shortage or lack of facilities, staffing, textbooks and funding. The focus here is on issues related to the qualitative dimension of science and technology in education as it currently exists in Uganda -- with a direct bearing on how science, technology, and the potential of indigenous knowledge provide frameworks or ethos for fostering sustainable people-nature interactions. The participants included Makerere University academics, selected students of Makerere University, Ugandan government policy officials, high school science teachers and elders from the Osukuru community in Tororo district of Uganda. Views of the participants were solicited during individual interviews, focus group discussions and in a workshop. Some excerpts from the Uganda government White Paper (1992), the Makerere Visitation Committee Report (1970), the Constitution of Uganda (1995) a central policy document, science, and science education course outlines, as well as some research reports by science and science education graduate students were studied and used to augment the participants' inputs.

5.1 Science and its Role in Society

As a developing country in pursuit of rapid development, Uganda seeks to transform its economy by utilizing science and technology. In the new Constitution of the Republic of Uganda(1995), this goal is clearly laid out:

> In order to facilitate rapid and equitable development, the State ...shall stimulate agricultural, industrial, technological and scientific development. (Constitution of the Republic of Uganda. p. 4-5).

To gain an understanding of what this national expectation had of science, this study sought some views about the operations and choices made by Makerere University in relation to the construction or reconstruction of science to facilitate the achievement of the national goal. Akiiki, a professor in Physics and also teaching in the Department of Chemistry, viewed science as a means by which...

> ...we always try to understand nature or creation; the mechanics, energy, and the forces involved. In this process applications have risen. We still believe that with science we could continue to understand one's environment and make use of it without destroying it. In its teaching at all levels, one is given basic principles, facts, laws, which as creation has it, cannot change. In science one raises questions, makes observations, records results. Some of them are taken for granted or are constants. Later in school the teaching curriculum tries to develop these principles. I think later in the vocational system the applications, which have not been so much emphasized, have not been well suited to our needs in some cases, and from which bad consequences have also resulted.

Akiiki presents a docile image of science. By explaining the role of science as one which only explores one's environment but does not destroy it, Akiiki paints a benign picture of science as a process by which its aspirants get in touch with and explore physical reality. In this context, science has the power to feel, explore and discover rather than to transform the world. This picture of science conjures up an image of pure science: pure in the sense of being virtuous, autonomous, and absolute; and elitist in the sense of being abstract, conceptual, theoretical i.e. innocent and blameless.

Akiiki demarcates between his vision of pure, innocent science and its 'applications', which we can interpret here as technology. Akiiki's perception appears to be premised on the conceptual separation between "pure" and "applied" science, and by which the consequences of technology and its uses to transform the physical aspects of the Earth and quality of life in general could, in this separation, be seen as independent of pure science. Akiiki therefore places the responsibility and blame for misapplications of science solely on applied science or technology. Later we will encounter similar views from another science professor who shares his views about developments in science and its environmental impacts. By divorcing applications from theory, Akiiki attempts to isolate the scientific generation and refinement of models and principles from their practical applications and subsequent impact on natural phenomena and society. He also sidelines the reality of the use of natural phenomena not only in refining scientific models, principles and technological prototypes, but also as the focal interest for the manipulation and control of nature, people and their cultures. Many scholars are, however, increasingly critical of scientific inquiry, pointing out that it has instrumental or technological values with interests focused on efficacy (Franklin, 1990; Capra, 1982). Contrary to Akiiki's view, Capra and Franklin argue that neither the instruments (technology) nor the values of efficacy is devoid of aim or functional purpose, and hence, of effects, thus affirming that science has explored nature from sheer curiosity to the human imposition of our will over nature in search of money, pleasure and power (Merchant, 1980; Keller, 1992). These pursuits and achievements of science are seen by these scholars and the elders of Osukuru, as giving technology a sense of direction. How then can science begin to incorporate a concern for ecological and social sensitivity? What would the criteria be? Akiiki asserted:

> The Institute of Environment now in place at this University has tried to address a number of these environmental problems I suppose. As I said in the teaching of science we do teach the principles and understanding of what is around us. Of course we attain the knowledge. Sometimes we derive applications accruing from this knowledge. But you see man may understand something, but the right application may evade him. Just as man invented fire for cooking and warming, he still goes around burning food. He invented the spear to help him kill the animal, but he can spear his friend. The knowledge which science gives to one may not necessarily change his character and behavior. In the same way these engineers well know the ill effects of alcoholic and poisonous materials which they dump in our Lake Victoria or in the air. They know that. Just like the doctors know about smoking and its consequences but some still smoke. Just as people know about AIDS and its transmission they still go about doing things they know will get it to them. Human nature is one of the causes.

Akiiki responded to the question of the role of science programs in facilitating some awareness of its misapplications which impact on the environment and eventually affect social quality of life as follows:

> The Ministry of Health and NGOs are in place to sensitize people so that they are aware of these thing. The problems in the environment, I think the Ministry of environment is there to make people aware and many others. I think those organs should do that job. We cannot say that we can develop a different curriculum in science to sensitize people. There are those organs which really do sensitize people and give this information. And the majority of people really know for example the environment has been so much talked about. Almost everybody now talks about it. There are two kinds of discipline areas in which that attempt is made. One is the religious sector where people are given the opportunity to know the nature of man and how he should respond to the fellow man and their creator, the values. The other is the Social Science which deals with the impact of social, political impacts of science, developments, and sensitizing people.

In this response, Akiiki concedes to the existence of environmental problems but ascribes the responsibility of educating and mitigating the ecological problems to 'other' specific disciplines. He blames environmental destruction arising from industrial processes to the poor moral nature of humanity. Akiiki changes his original perception a little: he sees the potential for using science in the exploration of nature to create more understanding of the universe but views the applications of science as problematic due to the lack of accountability among scientists. In this view, the selfishness of humanity hinders construction of a great social heritage for the individual and for cultural progress, and is responsible for the heavy decline in the environment and, in turn, people's quality of life. But he acknowledges that the goals of progress and social success have been purchased at the expense of major ecological and social cost.

In response to the question of how Makerere University could evolve science programs that could also inform and guide learners towards social and ecological responsibility, Akiiki takes a rather defensive stance which isolates science from its misapplications. He identifies the process of science as that of simply increasing knowledge of the natural world. With this logic, responsibility is shifted outward, away from the pure scientist who is only responsible for theoretical knowledge, to the technicians who are expected to perform the practical applications, and finally to the social workers and politicians who choose to use them. This vision of science could auger tragedy. Science has a long history of being the catalyst for creativity in people. In a more socially and ecologically just agenda in the contemporary situation of the twentieth century, science can also become a potent source of creativity. But Keller (1992) notes that there are dangers to be shunned, pointing out the chain of events linking basic (or pure) Physics to the nuclear bomb. The optimism

Keller's observation provides for scientists and science educators is that the dangers, ills and opportunities we confront at these times of ecological and social disharmony also have the potential to inspire scientific and technological creativity and dialogue, if scientists do not take refuge in the classical ideal of a neutral and disinterested science, aloof from what Galileo labeled as the passions that divide men. As Gore (1992) notes on how we relate to the environment:

> No wonder we have become disconnected from the natural world... And no wonder we have become resigned to the idea of a world without a future. The engines of distraction are gradually destroying the inner ecology of human experience. Essential to that ecology is the balance between respect for the past and faith in the future, between belief in the individual and a commitment to the community, between our love for the world and our fear of losing it-the balance, in other words, on which an environmentalism of the spirit depends (p. 242).

The denial we witness from Akiiki perhaps shows how the science community in Uganda has failed to recognize the need for close ties with the social realities in Uganda and to make a commitment to creating a public awareness capable of recognizing and framing effective solutions to societal problems. As a product of the same system of education, for the most part, my personal experience confirmed that once one registered for science subjects in high school and eventually moved into a science-based degree at university, there is no opportunity to pursue complementary courses outside the Faculty. Akiiki offered a possibility:

> ...when we switch to a course unit system. It will be much more flexible to pick courses first of interest secondly the requirements and I think those kind of aspects could be easily incorporated. The curriculum for our programs cannot really accommodate every aspect you want to give to the students. Some of these probably could float-in so that students can pick interest in some general courses.

Akiiki denounced the effort as cursory on how students are informed about the environmental changes by the current structure of science programs:

> But generally, at least in physics, when you do teach the applications or when we teach facts and principles we do touch both sides the strengths and weaknesses. We look in a theory for its strong points and weaknesses. I know in chemistry where there are direct health consequences caused by, for example, polymers.
> We teach the consequences of polymers; their environmental degradation. The city here is a good example where we now have bags everywhere. They are easy to use but the environmental problems they cause are tremendous for they cannot disintegrate. But these are facts which are known to the polymer scientists and to the industrialists. The problem is the

> economic force. This is a commendable force that drives some of the activities which create problems in environment.
>
> The industrialist is a businessman who is driven by one fact: to make profit. He wants to minimize costs by dumping the wastes to some convenient easy place available. You do that without considering the consequences because for them it is money first, and they have to compete and do not have time to think about environmental consequences. Of course the environment suffers in the long run.

While Akiiki's responses express a hesitancy to have science address social and ecological problems, his latter statements do show that one can teach science students about the dangers of some scientific and technological products. For example, it can be taught that polymers are non-biodegradable, have a long persistence in the environment, do seriously affect drainage and when burnt, produce toxic emissions. He also questioned the profit motivations underlying environmental destruction. With this level of awareness, Akiiki exposes the capacity of the science curriculum at the University and indeed other levels of education, to raise such issues and negative effects beyond theoretical excursions into physical phenomena typical of scientific discourse. As Smyth (1987) has observed, "Many of the world's problems are the results of science and technology misapplied" (p. 49). The inclusion of scientific, technological, development and environmental issues and their inherent contradictions accord science in education a strong influence on the current applications of science and technology and their environmental impacts. A balanced growth now may demand that control of science and technology be coached by an advancement in knowledge for the responsible uses of science and technology (Orr, 1994; Berry, 1988). Such an understanding can be derived from examining past mistakes and accord a seal of appreciation of the intricate linkages between the ecological and socio-cultural components within the whole system. The challenge exposed for Makerere University and indeed the education system in Uganda is for science to work with other disciplines, including closer interactions with the wider and majority rural populations. Akiiki expresses both awareness and a degree of openness to relating science and technology to societal and ecological consequences, pointing out:

> ...you would need to integrate your knowledge of a social scientist and physical science. So if you are going to take your students to interact with the rural community, then you need to have another different program in which you incorporate the social scientist ways of studying things into our scientific approach. The engineers seem to be trying to do that. They have programs where students would interact with the industry. I don't know how far they went with rural communities. But I suppose it could be done.

> Probably a final year physics student could do that having acquired some basic knowledge and other undergraduate courses and integrate these and try to discover the tie between the rural community and besides most of our students come from rural areas, so one may not necessarily have to go to the village but simply collect the ideas from their early-life observations.
>
> But my only worry is that I don't know how much these days the students participate in the rural community activities for example in cultivation, grass building, social community work which is not much like wells. Those were common activities in rural areas, especially cultivation and harvesting, building houses, construction and maybe solving energy problems which are now wide spread in this country. It could be done. It would be a good program.

Akiiki's vision of integrating social and physical sciences identifies a strategic goal for establishing a cooperative plan for educating citizens about our environment. Such an integrated program at the University could facilitate the establishment of a comprehensive program, involving scientists, engineers, students and the wider public domain including indigenous rural communities, in the research and monitoring of changes now being witnessed in the environment. This would facilitate the interdisciplinary dissemination of information, sharing of knowledge about threats to the environment, and the development of skills for responding to the crisis. The current discourse in science earlier pointed out by Akiiki not only isolates the lived realities of people from education, but also ensures that the scientific knowledge students are exposed to has, for the main part, no direct usefulness to the lived realities of their communities.

Historically many scientists and technologists have adopted the model of science, its refined methodologies designed to ascertain efficiency and precision of observations, data collection, experimentation, data analysis, interpretation, evaluation and prediction and characterization. The potential of this model as a vital tool to global environmental problems could be enhanced if its scope could be broadened to embrace holism (Warren, 1993; Ravetz, 1990). Apollo, one of the senior professors in the Faculty of Science had this in mind when he said:

> Environment is changing. Culture and society is also changing, although the two may not be changing at the same rate or even in a predictable pattern. science, of the powerful tools of systematic observation, experimentation and formulation, analysis and prediction, is capable of identifying key parameters which can be used to characterize environment at any given time. These kinds of studies lead to a number of parameters which can be used to develop models representing the status quo and for predicting future forms of an environmental system. Both theoretical and experimental models contain and provide suggestions and options for appropriate technologies to realize the desired results.

> Because of human activity and human causes to environment, the models and chosen technology should be expressed along mitigation options. Scientific and technological studies generate data; and if this data is found to be reliable, then there is a call for more people including scientists, policy makers, and end-users to suggest effective controls and accepted methodologies that assure sustainable activity patterns or practices in the environmental resource uses.

Apollo identifies two dimensions of environmental problems, the quantitative and qualitative. With respect to the quantitative dimension, he highlights the uses of science to investigate and attach some quantitative measurements. For example, we could identify the circulation of toxic substances in the environment as a result of some production and consumption activities, establish their levels of concentration, find ways of regulating those levels, and make remedial action, where necessary. From Apollo's view of environmental issues, he sees the role of science extending to broader ecological studies which investigate the synergistic effects of combined biochemical effects and biological interactions among large numbers of species and inorganic materials in large and small ecosystems. In this role, science can regulate and mitigate effects both for humans and for other species. The changing patterns of culture he mentions captures the qualitative dimension of science which targets those environmental problems arising out of our changing perceptions of the 'quality of life.' By pointing out the need for interaction among scientists, policy makers and various interest groups regarding the environment, Apollo acknowledges that social judgments in this qualitative domain can be based on scientific inquiry and quantitative data, such as identifying health problems associated with high noise levels. As earlier noted by Akiiki, Apollo's interpretation of the qualitative dimension accords science a position of advocacy acting as a vehicle for the ethos of complementarity -- the interdependence of life and ecological systems' balance.

Among traditional cultures in Uganda, the search for practical solutions to the increasing ecocrisis needs to encompass some aspects of traditional or indigenous knowledge based on the accumulated experience among rural communities. Responding to a question of how environment and indigenous knowledge can become an area of focus in scientific and technological discourse, Olupot (1995) draws our attention to first of all understand the original structuring of formal schooling which he argues not only physically separated schools from communities, but also discounted cultural values of traditional societies as "backward". Extending this observation, Neddi, a high school science teacher saw as a goal for an integrative education in Uganda as that of...

> ...removing the boundary between schools and communities. Getting schools linked to communities. Schools have been isolated physically with wire fences. It is still necessary to have fences. I am not saying we should

> remove the fences. But then with time the fences should go if we have to achieve an understanding and mutual cooperation, a give and take relationship between schools and communities. Right now when you enter a school, they rudely ask: *What do you want? Who do you want to see?* Then you are scared. It looks like there are sacred human beings inside there who should not be touched or seen. And then now the children never know what is happening out there in the communities.

Explaining how this physical and ideological separation between schools and communities creates a misconception and even lack of awareness of realities about community life among the students, Neddi narrated his experience of taking a high school girls' class on a field trip into Osukuru community and to a Tororo town slum:

> ...the students behaved as if they have never been in this country. They saw the real situation in a slum. They went to the village, talked to some people, even entered some houses. And they saw (what they couldn't have imagined. Now they say with insight: *In the village people are poor. In the slum people are dirty, crowded, filthy, noisy and sick and drunk most the day.* Now some of these students know where not to go on their own.

He went on to provide an elaboration of what he felt were the positive effects of this exposure of students to the realities of slums and rural areas:

> Students fear they will be polluted and so do the teachers and they are right. They don't have much to learn from rural communities and slums there apart from those negative things. They learn about over-crowding, spread of diseases, poverty. When children return from such a trip they know the place is terrible, and they shrink away from it.

Neddi's exposition brings to our attention a number of realities relating to the education and social life in Uganda. By pointing out that the students were alarmed at the wretched living conditions of slums and poor rural families, we gain an insight into the fact that most students in high school and beyond are children from middle class families whose better conditions of living are remote from the deprivation of the masses. Their parents are also sufficiently affluent to afford the high costs of education. Neddi's analysis of the morbidity in slums and his support for isolating the students from contact with these poor human conditions ignores the value of students' sustained exposure to these realities of the majority of the population, and would create an awareness of consequences of scientific and technological development. As earlier pointed out by the elders of Osukuru, the social transformation from cultural life anchored some meaningful social and ecological relationships. But the above reaction to social poverty by Neddi, a scientist and an educator, illustrates the impact of development based on technological know-how and economic efficiency on moral judgment. The message we get is that students and teachers prefer to distance themselves from the harsh realities that are endemic in the majority poor communities. The field trip, in Neddi's perspective, served a good deterrent for students to stay away from the evils of poverty. He underplays the positive contribution such continued contact between the youth and social conditions makes in creating an awareness and solidarity between the poor and the youth in education and later, their civic role in relation to these human conditions.

The student-community contact also works the other way. If there is a good model village with improved homes which students visit on field trips, they would equally identify with these positive contributions of science and technology in terms of improved water-wells environmentally improved kitchens, toilets, waste-disposal and recycling strategies, good roads, land reclamation, soil erosion control, inter-cropping of plants, and conducive social life, all of which are lacking in villages (Refer to Appendixes B3 and B4 of Deforestation and on Rural Water Supply). What Neddi and the students experienced about rural and slum poverty is a society utterly at the mercy of the market-place's allocative mechanisms, typical of the frameworks of modernization. Transformation of this reality requires that educators do not abdicate their responsibility in informing and clarifying the range of on-going forces, interests, choices and their possible effects, so that citizens can make enlightened decisions and choices for the future. Neddi did concede to problems of modernization and urbanization, and how application of appropriate science and technology could contribute to alternative and improved living conditions in the rural areas:

> People now frustrated in cities and towns, sleeping in a small crowded room would happily come back to the villages. No play ground for children and adults in towns is very tensing. There is a lot of space in the villages if we can appropriately improve the conditions there. When I get stressed up here I go to my village and walk in my gardens, in swamps, sit on a big range ground, read my book, relax, listen to birds. Even in the swamps down there - fish is playing in the water, watch and listen to the sounds they make. You come back feeling fresh.

Neddi's reflections here point out that the migration pattern of people, from rural to urban settings and the ensuing disappointment in expectations for a better life, need not persist indefinitely. He acknowledges the closeness and value of rural life to the relaxing effects of abundance of space and natural settings to which he commends people to return. Neddi describes his personal confrontation with the mental and social stress and the unwritten rules of modern, urban living and the need for healing. Likewise, what is needed is a confrontation with and a full understanding of the patterns of poverty among people and the ecocrisis deeply rooted in the dysfunctional relationship between modernization and the natural world, caused by the pursuit of scientific and technological development. Recognition of the destructive impact of these patterns on the environment and people is a useful step towards critical reflection of our losses, healing the damage to nature and to the majorities, and coming to terms with alternative life stories of social and ecological stewardship.

5.1.1 Science, Technology and Society

Among the means seen as focal to national development, the Ugandan government in its White Paper on Educational Reform (1992) and the Uganda Constitution (1995) advocates a scientific and technological revolution, with curriculum and educational objectives of comprehensive programs in science and technology at all levels of formal education that inculcate "scientific, technical and cultural knowledge, skills and attitudes needed to promote development[14]" (White Paper, 1992: p. 8). In particular, the government recognizes the need for the establishment and/or the reinforcement of intermediate technology for rural transformation. In this regard, the White Paper recommends that higher education pursue the initiation and development of an indigenous scientific and technological capacity to tackle the problems of development.

Lawino, an Adult Education student at Makerere University, has spent more than fifteen years in rural development programs with a number of non-government organizations (NGOs). Lawino voiced a feeling of great incongruence between science-technology as it is taught and practiced in schools, and the needs of Ugandans:

> Allow me to ask you: The Faculty of Technology here which trains engineers. Between these engineers and the persons who make the charcoal stoves, water tanks, motor-vehicle exhausts, wheel-carts, trailer-bicycles, shoes of all styles and sizes just to name a few: who makes more money? Who is making a contribution to the needs of Ugandans? Certainly this latter group of people because they are answering the felt need which is still within the level of the development we have in our society today. Our society is one that still uses the kind of things made locally by these artisans, that is why they have all the money.
>
> Our engineers from this university will be moving with a lot of papers looking for the right *job* or position while these artisans are there answering the needs and making the money in the process. Even in rural towns, who are the men having the more money? It is the foremen and the masons, because we do not need skyscrapers in this country that badly, even

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[14] *In the section on National Goals and Objectives of Education, the White Paper defines development as "Creating national wealth..." with implied scientific and technological tasks being "the development of appropriate and trained manpower with productive skills required for economic development." (p. 6)*

> government cannot afford many of these, you know. So the level is that of the people who are answering the felt needs.

According to Lawino, Makerere University should to try to blend the programs with an understanding of the lived and expressed needs of the people. She gave an example:

> On the use of charcoal stoves being made by the artisans, we should be asking the question of how this device could be used more efficiently, popularly and consistently to the benefit of the majority and to the environment. This is where we would seek collaboration from the physicists, chemists, biologists or ecologists, economists and so on to come up with a scenario to inform modifications needed on the stove, other than you going there to recommend that they need electric cookers because you have seen and used these in the cities or where you studied from as modern.

Lawino views science and technology in formal schooling as unresponsive to the lived realities and needs of the traditional communities in Uganda. At best, it imposes knowledge, skills, values on them not taking into consideration the level of their science, their technology and how they work with it. In her response, she feels that science and technology, as practiced in Uganda, is inappropriate and unresponsive to both social and environmental needs and social realities. In particular, the scientific and technological community in Uganda, according to Lawino, has let down the majority of the people in its moral failure to establish the necessities. Science and technology do not address ecological concerns and therefore have yet to evolve to a point where they could accept the responsibility for the creative design of affordable, socially responsible and ecologically sensitive technologies, activities, skills and attitudes. The on-going multi-million dollar expansion of Owen Falls Dam in Jinja at the foot of the River Nile, funded by the World Bank,[15] based on an assumption that rural households will have access to electricity, legitimizes Lawino's argument. Similar sentiments are echoed by Neddi, a high school science teacher:

> I believe that we in Africa here are in a mess, including Uganda; and our mess is a historical misfortune. Our technology never developed independently and it has lost its direction. We have grabbed a new technology without understanding it. And we have not mastered it.
> In Europe, or let me say the developed world generally, the medium of change is through the schools. Whatever knowledge, whatever information, whatever technology they have develops through schools and research institutions. And all their children pass through schools, and there is no way they can avoid meeting their science, there is no way they can avoid meeting their technology. By the time they get out into the community they have met those things and they are putting them into practice because they have found people putting it into practice around them

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[15] *The burden of payment of which will be borne by the masses.*

> already, so they go and carry on and it becomes a scientific culture. But in our situation here, there is a very small percentage of our children who pass through schools.
>
> If all children could pass through that system, now they are introducing Environmental Science, they are now lowering this technology, down, down to primary: teaching about agriculture, groundnuts, and so on. The system is good.
> If all children passed through our schools, and went out, and they found people out there in towns and villages making use of what they have learnt here, they would all grow knowing that this is how it is. But unfortunately, as very few of us pass through schools, and as they continue passing through one stage to another one, very many fall off, and you end up with only a very small number of people who really know something.
>
> When they get out of the communities, they are absorbed by that sea of ignorance that is around them. They are just absorbed and they disappear. So that now these boys - you think of that: Enrollment is about 50% in primary and as you go upwards the percentage falls terribly. Maybe at University it is 1% of that 50% which enters. So that is why our education system is not very useful, but I am saying that it is evolving in the right direction. And I do not think; no one should ever convince you, that you come and halt the system, and overturn it, no. It can be disastrous.

Neddi uncovers a number of issues in science and technology in an educational context in Uganda. First, he points out that the colonial influence of Britain over Uganda overshadowed indigenous science and technology with forms from the industrialized world. Second, Neddi acknowledges how science and technology are culturally constructed, and are best disseminated in the cultural milieu. Praising this success in the West, Neddi contradicts his first concern for the displacement of indigenous science and technology by expressing a wish that all youth in Uganda successfully "learn" the western science and technology through access to education - a provision which would facilitate the mass transfer of science and technology using the school as a medium of conversion. At this point Neddi becomes an advocate of technology transfer promoted by educational institutions as an appropriate development process.

Thirdly, Neddi simultaneously discloses the unfair pyramidal structure of education and access in Uganda, and that those who do not have the access -- but constitute the majority of Ugandans -- are ignorant. Neddi continued to express his disappointment over the outcome of education for most people, particularly those occupying influential government or corporate offices, who have used neither their knowledge nor their positions to improve the quality of ecological systems or quality of life for the majority. Instead, according to Neddi, the elite have acted in ways that have either kept the rural majority ignorant and uninformed or directly contributed in the exploitation and worsening of the conditions of the ecosystem and that of the people. He shared this observation:

> There are some elite who go to their countryside homes and make people drunk, and it has developed into a culture. In my village if you are a government servant or somebody who works somewhere, you come home and do not buy booze (local beer) for people and make them sit and drink until they do not know how to go home, then you are selfish, you are not social, you are not wanted. It is because the earlier people who were in positions of responsibility did that, and village people now believe people in town should bring money and spend - and the only way of spending it is by making people drink and eat. And what do they talk? Nothing. *How is Kampala - raining? Yes.* That is all.
>
> They do not tell people anything critical about their situation. Some of them, including scientists and engineers have become very quiet while they are at home in the village; whereas they are very noisy, bossy, arrogant, even outright intimidating at their places of work. In the village, these elites do not know how to talk to the villagers and therefore they do not know what to tell the village people. I think they feel what they know what is too much for these rural people.

In these reflections, Neddi articulates a crucial role that he feels the educated, scientists, and technologists should have engaged in, but for which the opportunity has been miss-used in their informal but yet influential interactions with the rural majority. Neddi's view is that with a more creative and visionary values, perceptions, and aspirations on the part of the Ugandan elite, they could have inspired the rural people to critically perceive, assess and act in concert with their needs and that of the natural environment.

Having been cut-off from their cultural bases, Neddi sees the elite as having faulty perceptions of the needs in rural communities. He confirms this by pointing out the misguided actions of making people drink rather than conscientizing them. He sees the elite values as being incongruous with the communities' priorities and certainly with environmental realities. Lawino and Neddi's discussion of this disparity between thought and philosophy among the scientists, engineers, other educated elite and the traditional rural person could be indicative of the alienating impact of the curriculum. By expressing kinship through purchases of alcohol for the village people, the elite, at best, engage in creating artificial and temporary bonds with the rural people that are bereft of an ideological or cultural base.

To Neddi, the Ugandan intelligentsia ...

> ...never knew people's problems. They came to regard the village people's problem as that of money for booze. And the villagers got tuned like that so now when I go to another village, where they do not know me, they disturb me like they used to disturb those predecessors. They say: *See you aunt. See the dress, the way it is torn. One time you will come to bury me just. You do not even visit me. Oh, I am really lucky to meet you today. I think soap today will get. Even these dirty clothes will be washed today.* That is

> the mentality of the villagers, and it has scared off many city people. Now they see villagers as beggars. If I could take you to my locality where my people know me best - and that is where they would really beg - it is pitiful. These people need to be taught. And our people who first got the light, never did it.

Informed action is preceded by perceptions and guided by values which schooling should engender among learners. Neddi seems to see this shortcoming in our education in general. He also assumes that modern schooling has developed the capacity for critical analysis and thinking among the educated, empowering them to teach the poor. In his discussion of manpower development and knowledge dissemination in institutions of learning like Makerere University, Olupot (1995; p. 98) informs that:

> (The) privileged position of the elites is dependent on the poverty of the masses and it is therefore naive to expect them to act for the betterment of the majorities especially if their socialization reflects principles, values and strategies of the dominant modernization paradigm.

Olupot's analysis documents the great scientific and technological progress, the vast flows of information concerning ecological crisis, economic warfare, cultural intolerance, and crime. Mired under the sociological truth of modernization, credentials serve as instruments of social selection which privilege those who manage to have them while marginalizing the majority who do not. Olupot's view and Lawino's observations reflect the understanding that scientists need to evolve indigenous perspectives of science and technology in relation to the critical issues of technology transfer, appropriate technology, and the massive destruction of the environment associated with technology transfer.

The accounts above regarding the role of the educated, the scientists, or applied scientists were supported by Wakki, a professor of Mathematics who shared that

> In this university water pipes were laid many decades ago. A colleague of mine in the Estates Department told me that the University Administration is getting worried that the current numerous pipe breakages in the university water supply could be a signal that the pipes need replacement. In asking him whether there were any calculations and indicators on record about the lifespan of the pipes, his response was that at the time of laying down the pipes, no one was bothered about those kinds of questions. In my view the scientists or engineers should have provided calculations to give projections of what the problem with the pipes should have at this time.

In this story, Wakki focuses on what he considers an ad hoc use of scientific and technological knowledge, identifying little or no regard for even the very basics of scientific discourse, namely prediction and control. He fears that with no built-in concerns for the future, the continuity and relevance of science is not engendered. We meet more reflections about science, technology, environment and curriculum in several upcoming sections.

The ebb in indigenous scientific and technological knowledge earlier pointed out by the Osukuru elders, the looming ecological crisis in Uganda and the revitalization of these sources of knowledge is conditional to appropriate and timely revisioning of priorities. As an institution of higher learning in the country, my expectation is that Makerere University has, or should have a vision motivated by its position as the first university in the country and the East African region, to serve and nurture the values, aspirations, and heritage of the majority of Ugandans.

5.2 Science and Science Education in Makerere University

As explained in the first chapter, the Faculty of Science at Makerere University now offers three-year undergraduate and two-year postgraduate degree programs in the Biological and Physical Sciences with a broad range of science disciplines such as Botany, Zoology, Biochemistry, Physics, Geology, Statistics and Applied Economics, Mathematics and Chemistry. Postgraduate training in most of these subjects has been running for several decades, including the Institute of Environment and Natural Resources which currently concentrates its programs at graduate level in Conservation Biology, with a field station for Ecology in the Rwenzori Mountain range in the Western part of the country. All the programs involve extensive practical laboratory work in all subjects. The Statistics and Mathematics units have acquired computing facilities which also include some laboratory work. Various units in Biology, Industrial Chemistry, Physics and Geology disciplines entail some field work including workshop practice for Physics students.

The emphasis placed by the Ugandan government on science and technology tempered this study's exploration of staff and students views on curricular options and focuses in relation to the role of science and technology in development. This search began with an inquiry into the disciplinary perspectives and theoretical interests of science programs at Makerere University, in particular the extent to which science programs have critically captured ecological and social issues. An inquiry was also conducted into the responses of Makerere University students to this cultural formation and its implications to social and ecological sensitivity of science at the institution. Twaha, one graduate student from Humanities, was happy to share his views based on his interaction with graduate students in the Institute of Environmental Science at Makerere University. He said:

> I have friends in this university doing a masters degree in Environmental Science. The approach of Environmental Science in this university is purely empirical. The students in this program consider themselves

> environmentalists. To claim to be an environmentalist is to declare it a monopoly or a profession, and to exclude everybody else. This claim is also very disappointing because each person has a role to play. Each species that survives in the environment has a role to play in the whole system. Even a tree does something good for us, instead of us to the tree. Looking at the topics of the MSc Environmental Science theses, they deal with birds, swamps, forests, Lake Mburo National Park animals and or fish, and pollution on Nakivuvo channel. These studies on environmental degradation views the problems as if they are independent of people and people's condition. This is the whole approach used in this institute. People in this institute have tended do research on symptoms rather than on the fundamental issues involved in environmental problems we face in this country.

As an "outsider" to the University's science programs, Twaha's involvement in a study of society and environment in Uganda made him a useful contributor. His perception of science molding students' beliefs and its independence from social or political contexts would promote an understanding and development of Environmental Science knowledge as dependent and derived from within the "disciplinary approaches." Twaha's interaction with his peers in the Environment Science graduate program at Makerere has given him an impression that the scope of the program, and the outlook of science and Environmental Studies is too narrow to foster students' critical thinking about how people are or should be functionally located in the natural environment, and in broader terms, too restrictive to promote holistic understanding of ecosystems. Expressing what he felt was disconcerting about the attitude of the graduate students in Environmental Science, Twaha continued:

> They wonder why I should talk about Environmental Science when I am in the arts faculty. They told me that even if they explained to me why they are doing it the way they are, that I, being in the arts would not understand. These are my friends here; fellow graduate students. So we all end up laughing it off. So I got my point and let them go around with their tools for mapping, for digging, gum boots, nets and so on. When you question that there is something needing their focus, they are contented in telling you that you do not understand. You are seeking a holistic understanding, they are contented with a fragmented view of things as they see it. Besides they want to finish the research and get the award of a masters degree in Environmental Science; and they say this arrogantly as if other sciences or disciplines are useless and have nothing to do with environment.

Twaha expresses concern over the disciplinary nature of the Environmental Science program which he sees as a barrier or confinement of the concept, and of the processes of critical inquiry and practice. Viewed from Twaha's perspective, the disciplinary orientation of the Makerere Environmental Science program is akin to what Gaff (1989) described as a "bureaucratic device for organizing academic life" (p. 57). Therefore, in terms of knowledge generation and dissertation, Twaha appears to view the disciplinary orientation of the Environmental Science program as educating the students with blinders rather than lenses, limiting, rather than enhancing their vision of the interconnectedness of environment with other aspects of being. While I was able to access a few research reports and theses (which are discussed below), access to the collection of science graduate theses reports at the Institute of Environment was limited. However, Twaha's observations were corroborated by Nadda, a doctoral candidate at the Institute of Environmental Resources, who is also engaged in teaching. Nadda has been a student in the Faculty of Science since her undergraduate program. We will encounter a lot of her reflections later in the discussion. At this point, we share her experiences and reservations over the Environmental Science program:

> ...even within the empirical perspective, we still have a narrow approach to Environmental Science because we are strictly looking at conservation sciences like botany, zoology: looking at species distribution, utilization, land use and conservation methods. We are slowly coming to soil, wetlands and water. Our notes on pollution are at most a few pages, covering definition, types of pollution, causes and some example. The same for energy.

In other words, the actual scientific rigor of the contaminant behavior and trans-media contaminant migration, the treatment of the issues involved, and implications for aspects like critical policy and regulatory options are areas which Twaha and Nadda both see as lacking. Energy and the technological as well as the environmental planning were other areas needing attention, particularly given the rural and peri-urban energy and environmental crisis among the poor. In this respect, the concern for science in education is the link between science (including Environmental Science), technology and society. Appendix C presents a summary of science and science education courses at Makerere University, giving some idea of the limit in scope of treatment of Environmental Science, and science education and related issues. The echoes of Twaha's and Nadda's comments therefore legitimize the concern that Science, and Science Education students in Makerere University are not developing the kind of scientific understanding they need to make informed decisions.

Zungu, a long-term expatriate professor of Zoology at Makerere and an active participant in administration, teaching and research at the current Institute of Environment, explained future prospects of programs at the Institute at Environmental Science in Makerere University:

> The Institute has been asked by the authorities at Makerere to broaden its activities from simply science to effect changes - status from being part of the Faculty of Science as it is at the moment to becoming an independent Institute in the University so that it could then broaden its activities to include environmental law, socioeconomic concerns and other areas which can't be considered within the Faculty of Science. And we have began the process of considering how to go about this. So this Institute itself is increasingly getting concerned with wider issues of the environment. With regard to its teaching programs we already do include a small amount of environmental law, economics, but they are very small amounts. But these will expand.

Zungu's remarks here certainly auger well for the potential of the Institute to include a wide range of topics that would facilitate the conceptual and skill development of Environmental Science graduates in order to meet the country's current development needs and future socio-economic demands for development. For the present, Zungu mentioned the involvement of the Institute of Environmental Science in the escalation of ecological problems arising from development in the country.

> Things like environmental impact assessment, conservation ecology, we are also very much involved in some basic concepts on pollution and energy, and Remote Sensing. The staff are involved in investigating all major projects which could affect the lives of people who live nearby or far away for that matter. Those are now mandatory for all major developments in Uganda and we are involved in those.

Apparently, the newly established Ministry of Natural Resources in Uganda relies heavily on the available expertise at the Institute and other departments in the Faculties of Science and Humanities. Zungu's explanation relates to the collaborative efforts between the Institute and other departments in planning to address the country's environmental problems. As yet, these activities do not engage students or the rural people either. This was made clear when Zungu said:

> There are now a number of faculty in Makerere who are concerned with environmental issues and how they affect people; because, in my case we often work with people from Department of Sociology, Department of Economics, and so on, in the activities that we do at the moment. Not so much the teaching activities - what we do are projects, consultancies, such as environmental impact assessment.

University academics' participation in such projects as pointed out by Zungu did not involve any aspects of teaching but rather were organized on a private basis in support of mega-programs between the Ugandan government and international or private organizations like United States Agency for International Development (USAID), World Wildlife Fund (WWF), European Union (EU) and many others. Zungu also explained that the participation in these organizations focused on conservation of endangered species, thus limiting their contribution to the University Environmental Science program (through participation of students and staff) in terms of their project framework. While a contribution to the conservation of disappearing species is a commendable conservation effort, the active involvement of organizations like the USAID, (Olupot 1995: p. 162) with the Agriculture program in Makerere University...

> ...reflects the continued interest by the North nations to perpetuate worldviews and processes of knowledge production and validation which shy away from challenging the global status quo that greatly benefits the minority North populations who live in abundance vis à vis the rest of the world.

As explained by Zungu, the usefulness of wildlife conservation notwithstanding, omission of locally informed priorities limits students' and academics' participation to that of simply being hired hands. Any message which discounts local potentialities like indigenous knowledge signals to students that the only scientific solutions to local environmental problems will inevitably be dependent upon knowledge from "expatriate North."

An inevitable question then is: How can Makerere University educate to participate effectively in response to environmental degradation in Uganda? Apollo, a member of the Faculty of Science for many decades, and former Department Head and Dean of Faculty of Science expressed this view:

> The realization of the degradation of the environment and associated response strategies is probably a recent undertaking of many countries. I think the Institute of Environment which is a specifically assigned unit here at this university to look into environment should be able to get many other departments to participate in its programs.
>
> I think that this is what the Faculty of Science of which the institute is a brain child had originally envisaged. At the moment, however, it would seem that maybe there is more emphasis on the biological, even then, on wild life observation, characterization and to some extent, preservation.
>
> There are very crucial areas wanting in our Environmental Science here like energy, waste management and utilization, pollution and contaminant behavior, earth and atmospheric sciences, land use, environmental law, environmental economics, environmental policy and many others which can be a direct contribution from other departments at the faculties of science and others as well.
>
> I am aware that the faculties of Arts and Social Sciences have been waiting to make a direct input as well into the institute programs. There is, however, the question of funds as well. And with many faculties and large numbers of students, diverse programs in science, medicine, agriculture, forestry and

> others which relate directly to environment, the human resources may not be much of a problem. Having directed funds allocated to some of these activities seems to be one of the main problems that the university is facing.

Apollo broadens Twaha's view of a bureaucratized and scope-limited program and extends reflections on the Environmental Science to the idea of democracy. Apollo appears to locate science as a social process and therefore one that can be restructured in a variety of ways. He calls for the reconceptualization and reorganization of the Environmental Science program to recognize the high but ignored potential of the various science disciplines, and to functionally acknowledge that each has important conceptual and skill contributions to make to the whole. Apollo's response implies that in the proper framing and mitigation of environmental problems faced in Uganda and the merging of complex ecological and associated social issues with education, each scientist needs to participate in the inquiries, generation and sharing of knowledge, and the building of collective understandings through integrated science programs. The constraint to diversification in Environmental Science programs at this University was seen to be the disciplinary bias and influence of the individual originally appointed to handle the program on the program content. Apollo advocated an approach whereby, besides the Institute of Environment programs, the University strengthens some of the existing units in the various departments related to the environment.

In Physics for example, there are small projects on biogas, solar energy, radiation and biophysics, geophysics and seismology, and a clay projects. All these projects have limited funding and are under the supervision of individual academic members. Low funding has meant that equipment and student participation is extremely low. The Chemistry Department has similarly organized mini-projects, one of which is the extraction of medicinal products from indigenous fauna and flora in Uganda. Here again, the professor involved has insufficient funding to take on students on a formal science program, except through individual assistantships at graduate level. Discussions with Professor Odyek regarding the medicinal extraction research project informed me of such a shortage of funding from which he must draw his meager salary to further his research. The same was true of the biogas project in Physics. Donor support facilitated the initiation of these small projects through the provision of basic equipment and small, if any, additional financial support. The introduction of a University policy to strengthen and sustain some of these departmental programs was Apollo's view of enhancing comprehensive Environmental Science literacy. There was a strong feeling however, that the basic Sciences, namely Biological Sciences, Chemistry, Physics, Biochemistry and Geology must maintain their disciplinary orientation in order to deepen students' understanding of the specific disciplines. In defense of this line of reasoning, Apollo pointed out:

> The problem we face in developing countries is that we carry applied sciences a little bit too much. There is no such a thing as applied without understanding the basic discipline. So we can build up the institutes for specific applications with a professional bend but then, without the ability to generate data, we cannot model. We cannot suggest what methodologies should be used without core staff capable of generating empirical data. So it is mainly because of impatience and expectations that people think we are spending too much time on basic study. You see you cannot talk about applied. You are applying what? You need to have developed a mind that is conscious of getting deep.
>
> How can you begin to characterize a system when you do not depend on the basic knowledge on generating parameters - identifying them, and trying to evaluate which ones contribute what, which should be shade off and at what (time) stage? That is basic science. So whether you have an institute that is applied, most people look at community application; but that is the end product. At your base, at the institution, you find that you need these basic sciences. You go also to the other extreme: that students do not like superficial things. In physics if you do not write an equation, then you have said nothing. So you have to learn to write these equations, quantify them after (some) models; then who is going to apply the methodologies? The same person. It is then at this point that you can call upon people who say: *We apply it. Let's do it this way.* But it has got to be interaction of these two groups. It requires some level of interdisciplinary approach.

Apollo's strong vision of science in education is first and foremost focused on learning the basics of a discipline. He credits this as an approach for codifying and systematizing the building blocks of the discipline, the triumph of which he points out, is the explicit capacity to be able to describe systems and characterize them. He makes a strong argument in favor of disciplinary science not only for knowledge storage but for setting guidelines for the generation of new knowledge and ordering understanding. The orderly inquiry of science and technology have helped, in his view, to shape the modern age and have made a contribution to enhance the quality of life, at least for some groups. Some scholars, however, would respond differently to Apollo's view, particularly with the emerging complex interactions now evident between society and science, technology, the natural environment and development pursuits. Strict pursuit of scientific rationality in discourse is seen by an increasing number of scholars as problematic. Hurd (1991) for example, advances a different view in line with the educational implications of continued adherence to disciplinary science. He cautions us of the rapid proliferation of science through increasing specialization. His fears demonstrate the problems of over-specialization where a scholar becomes an expert in his or her unique corner of the university but is unable to comprehend or speak to others. Hurd accordingly urges educational institutions to concern themselves with educating scientists who can facilitate visioning of the big picture, rather than simply knowing the depths and details of a tiny corner of the cosmos. There is also concern about the need to bridge the bipolar worldview existing between science and the humanities. Cordes (1993) for example, explicitly denounces the inability of either technology or economics to answer questions of values and justice.

In spite of the obvious successes and advancements brought about by science and technology, Cordes expresses skepticism that science knowledge alone will suffice for the future. The traditional assumption in educational contexts, that knowledge should be categorized along disciplinary compartments and presented in sequential hierarchical order to students is increasingly being challenged. Hurd calls for "reform ... to prepare students for the twenty-first century" (p. 33); declaring the discipline-oriented curriculum as "indefensible" (p. 33). He accordingly urges science programs to "reflect the ethos of modern science and technology; that instructional goals should focus on the welfare of individuals and societal needs..." (p. 33). In the context of this study, we can add the focus on ecological balance needs.

Norgaard (1994) and McLaughlin (1993) further extend science's shortcomings in handling the complex nature of environmental problems. They argue that the objectivity of scientific knowledge, which is often based on a simplified world of the laboratory, makes it incompatible with the use of scientific findings to make value judgments and predictions regarding the complex world in which we live. In their view, the objectivity of science has led to domination of nature, and thus motivates an alternative ideology of nature that severs the connection between science and domination. Hence an alternative that would allow scientists and the majorities alike to see life as one, a combination of human and nonhuman nature, might be the basis of a new science. Such a science could help to legitimize a respect for all nature and would be of significant importance in the creation of an ecologically sane society. As Orr (1994) inspires, making science skeptical of itself is one way of freeing it from its confinement. This makes the argument for interdisciplinary inquiries plausible for handling the complexities of increasing environmental problems of the twenty-first century.

The Visitation Committee Report (1970) in its critique of Makerere University programs, pointed out that their design for purely academic pursuits and excellence lacked attention and relevance to the needs of Uganda. However, the Committee's concerns for relevance are only stated in general terms. The poor state of the natural environment, as witnessed through the voices of the study's participants, would mandate a rapid transition towards the creation of an awareness and new trajectories within scientific discourse. The goal underlying the establishment of a framework for relevance would be to capture both the potential advantages and tensions in science and technology in relation to development pursuits, population growth and impacts on the local and global environment. As Meade (1968) has discussed, the spectacular events in science and technology threaten to push society across the threshold. Noting the magnitude of conveniences, interrelations and synergistic effects, Meade points out that scientific knowledge has become the central capital and a crucial resource of the economy. The new order science and technology has fostered the mass production and distribution of television, fast foods, faster transportation, agriculture and other aspects of human life including health and contraception.

The challenge raised by the Visitation Committee to relevance of such programs should take its cue from Meade by seeking to attune knowledge to the problems that the Ugandan society needs to solve. This task demands that science and its technological derivatives become a continuum shaped by applications to problems like water supply and quality, food security, nutrition, health, energy needs, natural resource management, and its organizational framework should be redesigned to tie directly with social and political action.

Science, as a form of knowing, has potential to instill among learners, a range of diverse competencies in the context of the ecological problems facing this country. This study raised questions regarding the role of Ugandan scientists in stemming the environmental degradation. To what and to whom is science in Makerere committed? With deep emotion, Wakki, a professor of Mathematics at Makerere University said:

> We have made the polytechnic too technical, so dry and so useless; and Makerere too theoretical even among the so called professional courses, and therefore of little innovation. So amidst the environmental and social problems we face in this and other countries today, should we be surprised that no one is solving our problems anyway? How many examples used by our professors here are as a result of our major problems solved in this country? When I was in Guelph, examples were drawn from problems solved in Ontario, often by the professors in Guelph itself and the rest of Canada; with only a cursory reference to the international situation. But here we are still giving examples solved in Britain, and elsewhere. We are failing to internalize knowledge, to internalize science.

Wakki's response is a double-edged attack on science and technology and their failure within the educational and social settings in Uganda. His feeling is that these two fundamental forms of knowledge and skills have not been crystallized in the Ugandan educational and vocational frameworks to project their potential as catalysts for innovative use and change. In other words, Wakki does not see that science nor technology has bridged peoples' thinking and feeling. The creativity inherent in science has not moved beyond the confines of books and laboratories to the real centers of learning -- society and its realities in Uganda. This tends to arise from handling information in segmented subcultures which prevents the acquisition of evolutionary literacy -- the capacity to integrate knowledge, visions of humanity and their concerns in a holistic perspective.

In Wakki's experience, with the exception of the Radiation Physics project which is seeking to establish levels of human irradiation from UV rays, the Ethnobotany and Ethno-onthology study units on traditional uses of natural resources in Biological Sciences and the Institute of Environment, linkages between Makerere University and the communities were extremely few and often used for the purpose of extracting information. He comments:

> Once the community has helped them identify the problem, they never come back to the community to find or share findings and feasible areas for community participation . They do not. They look for the answers from their books based on related literature, and impose these onto the community. You see, if 80 per cent of the time is spent in the lecture theaters, labs in this university, making sure that the students get the basic understanding that someone with a degree should have, they have nothing to do with solving the problems associated with the outside community of this university directly. If a university were to get involved in problem solving, it must first establish a portion of its time on programs that deal with (related) problems. This university in some sense as far as research is concerned is almost run down because senior people who would be leaders in this respect are involved in administration: head of department, dean, director, and so on. They have no time to think about problems.

These remarks carry serious implications for research methodology used opportunistically by researchers who abandon the communities after the information has been extracted. As Rahnema (1990) points out, an inclusive ecological image which proceeds through experiences shaped by participatory relationship accords an experience of each participant and allows the community to get internally related to the whole. What Wakki notes in some of the current university-community interactions is one where communities are simply providers of information. To Rahnema, these forms of engagements do not foster transformation, participation and accountability as organizing principles of ecological and cultural balance, but he also admitted that not all the scientists and science-based programs completely shun community interaction. Wakki gave an example of the National Agricultural Research Organization (NARO):

> some of the colleagues in the National Agricultural Research Organization, (NARO) are tackling problems like the cassava mosaic disease in this country; others in the area of increasing food production in this country which is also a problem. Of course they have their own problems of

> coordination and tendency to impose solutions to the farmers; but at least they are dealing with real problems that touch the people of this country.

Wakki maintained a strong stand that science should perceive itself as a problem solver as exemplified by the NARO efforts. With Apollo's important contribution in support of basic scientific principles and methodologies, this process could expand laboratory inquiries of scientific research to explore new levels of analysis that support socio-cultural and environmental needs and their implications for reconstruction of scientific discourse. In relation to the contemporary degradation of ecological systems, Wakki had a strong feeling that the University's teaching and research agendas need to be restructured to incorporate some aspects of indigenous scientific, technological and environmental knowledge:

> I have told a number of people that the fellows they call primitive used to live with a life expectancy of beyond eighty years while ours is now forty and less. I have asked: Which community was handling its nature better? Theirs, not ours.

Wakki continued to express hope that the national impact of the University's science programs would be greatly enhanced and enriched by the inclusion of some of the indigenous social and cultural elements. In particular, this would call for the identification of appropriate indigenous scientific, technological and environmental knowledge, and skills and processes which could become an integral part of school science. He gave examples of his grandmother's techniques for drying and preserving meat for up to a year or more; their elders preferred eating this form of meat to the fresh one, pointing out its nutritional value. He also pointed out that traditional alcoholic drinks from cereals (*bushera*) are more wholesome in nutrition value and posed less health hazards compared to the industrial alcohols. Having lived in a coffee growing area, Wakki also pointed out the efficiency of burning dried coffee husks which have been found by the rural coffee farmers to possess some high levels of hydrocarbons. Such local practices were, to Wakki, some key areas for scientific inquiry. Apollo and Wakki support the Sociology of Scientific Knowledge, a process which scholar Andrew Pickering (1992: p. 9) calls "ways of opening new spaces for thinking about practice". Before listening to other participants' voices on the role of science in Uganda, an examination of some examples of research conducted by graduate students presented below will enrich our understanding of the perspective of Science promoted at Makerere University science program.

5.2.1 Some Examples Science of Research Reports

An MSc thesis by Omoding (1992) investigated "*Energy and Industrial CO_2 Emissions in Uganda and its Effects on the Atmospheric Thermal Regime*" The abstract states in part:

> The objective of this study is to estimate annual carbon dioxide gas emissions from various energy uses, and also from industrial processes in Uganda. ...Carbon Dioxide is a greenhouse gas now feared to be contributing to increase in temperature (global warming). ...The objective is to correlate the trend of total annual carbon dioxide emissions in Uganda with a 30 year time series of temperature data from each of six selected locations in the country with a view to establishing, from a theoretical model of CO_2 effects on temperature and correlation between its aggregate annual emission levels in each of the temperature time series at each of the locations.

The thesis does address aspects that clearly capture the crucial environmental problem of global warming. In its findings, the study notes that there are only slight indicators of potential warming both from the theoretical model and from the time series in all the locations with the exception of Kampala City and one location in the western region where the time series indicated definite warming trends of about two degrees above the thirty year average temperatures. While concluding that there is no significant increase in temperature to cause concern in Uganda, the study attributed the observed warming trends in the city and the western region in Uganda to rising CO_2 emission levels from high fossil fuel combustion from the large number of vehicles in the city area; the low albedo (surface reflection) effects were a likely result of high deforestation in the area. The study's explicitness in scientific analysis cannot be corroborated with a holistic interpretation of other realities that impinge on the carbon dioxide emission scenario. For example, in its methodology, only recorded temperatures were used as the main indicator for change in the atmospheric thermal regime (climate). No consideration was made to tap the lived experiences or narratives about climate change on trends and related activities like energy uses, deforestation, and land use patterns which, as Watson et al. (1996) and Tegart et al. (1990) point out, contribute to CO_2 and other greenhouse gas emissions.

The study also overlooked the link from carbon dioxide emission from activities driven by market forces to impacts not only on the atmospheric thermal regime but to other interconnected effects like soil erosion, food production, loss of biodiversity, and quality of life of the people, particularly the poor majorities whose lives depend on land productivity (Bruce et al.; 1995). Uganda is an importer of fossil fuels. The thesis data shows an increase in imports of about 20,000 barrels of total fossil fuels into the country per year between 1988-1991. These imports were based on foreign exchange derived from cash crop exports like coffee, tea, cotton and other agricultural products grown by the peasants. The study fails to highlight the injustice of importing fossil fuel which often benefits the few rich, but whose import costs, environmental and social impacts are borne by the peasant class. Finally, by excluding the wider social and environmental concerns and focusing solely on the insignificant global warming trends, the study is in complicity with a *do-nothing* policy approach despite the mounting evidence of continued environmental catastrophes and associated social threats.

Another study by Dranzoa (1992) made an assessment of *"The Impact of Deforestation on Survival of Forest Birds in Mityana"* and used indigenous rural people's knowledge of birds (ethno-onthology) in the research setting to determine the sensitivity of birds to changes in forest cover (deforestation). The study's findings identified some high sensitivities among some bird species to deforestation in the area and its analysis of ecological disruptions. Habitat and food chain relationships are well analyzed in the biological framework of ecology, questions associated with socio-economic pressures of modernization, the active participation within the social stratas like the rich, poor, in timber and fuelwood are addressed. The study exonerates women from the bird-population decrease and attributes most of the deforestation and fuelwood use to men. The study could have highlighted the marginalization of the rural women in the decision-making process with regard to forest resource management. In its recommendation for reforestation programs, the study could have highlighted the gender disparities and supported the views of Chioma Steady (1993) for the inclusion of women in the analysis, and the process of sustainable use of environmental resource management and development. Above all, as Altieri and Yurjevic (1995) critically point out, for optimization of the reforestation program's outcomes, the study could have recognized the need for indigenous contributions and the integration of ecological approaches to forest and biodiversity management, and supported the combination of these elements with modern scientific approaches on the basis of cultural compatibility.

In the area of science education, very few graduate studies have been conducted within Makerere University. Of the few thesis reports available, there is a dominant emphasis on discussing performance and assessment and grades. This informs on the researchers' bias and belief of what constitutes areas of concern in science education in Uganda. Among these studies, Kaliba (1992) investigated *"The Predictive Validity of Performance in Chemistry on Performance in Biology in Uganda National Certificate Examinations."* This study's strategy involved the correlation of candidates' grades in the national examination for Chemistry and Biology using regression analysis. The investigation had as its focus, pointed in the abstract,

> To find out whether performance in Chemistry could act as a better predictor for a candidate's performance in Biology, or whether performance in Biology is a better predictor of performance in Chemistry.

In the findings, the study reveals that Chemistry performance is a better predictor of a candidate's Biology performance. Similar studies had been done by previous graduate students, for example, Wamakote (1991) investigated "*The Predictive Validity of Performance in Mathematics on Performance in Physics in Uganda National Certificate Examinations*," to conclude that any candidate's performance in Mathematics was a predictor for their performance in Physics. These studies have no qualms about extrapolating on the combined impact of content and processes skills, teaching methods, nature of science, nature of the teacher, the nature of the learner and the integral impact and understanding which, according to Jesunathadas (1995), has implications on the learning process and its outcomes. In contrast, both these studies conducted by graduate students of science education display a characteristic typical of scientific inquiries; Norgaard (1994), McLaughlin (1993) and Capra (1982) convincingly point out that their investigations are based on the separation of a phenomena from everything else in order to accord a focus on a single aspect. Therefore, according to these scholars, scientists gain insights into properties of isolated fragments of their subject of inquiry and present a strong case that the information gathered in the process is of little value for predicting the consequences of its application. A science educator might rely on such findings as a strategy for improving students' performance, but it is naive to expect such simple cause-effect consequences from teaching Biology and Chemistry, or Mathematics and Physics.

If my performance in Physics can be improved by my performance in Mathematics (because the latter is a better predictor of performance for the former) what can my teacher do to improve (or predict, *i.e.* control) my performance in Mathematics? These studies make many gross assumptions about the background and or cultural milieu of each student. There is a growing awareness among multi-cultural science educators like Hodson (1993), Atwater and Riley (1993) that as a body of knowledge, science should include our understanding and sensitivity as educators to group identification and culture (and we could add gender) as aspects and issues of concern in science learning and achievement. Feminists like Keller and Longino (1996) are interested in seeking answers to women's experience and perspectives of science, technology and education. As these studies would imply, the conventional view of science as a well-defined, infallible and all-powerful method and process and the value-free approach of scientists is being challenged. The deteriorating ecological quality and the alienation of indigenous cultures under modernization pressures demand that research and discourse in science and science education should aim for the development of a liberative science, one open to potentialities of being responsive to the human condition.

Drawing from the discussions held at Makerere and the analysis of the above research reports, we gain some insights as to why science and science education have avoided the locally motivated scientific and technological research agenda. It is evident that the goal and expectation is to remain within an objective model of science and science education. The justification for this framework was seen as a strategy for maintaining programs which were compatible models of science discourse from industrial nations. As one Ministry official happily pointed out,

> Once in a while, you have to show your flag at the Olympics.

Science and technology in education in Uganda sought not only to solve endemic local problems but also to compete in the international knowledge race. Rigga, a Chemistry professor, later states that taking interest in indigenous issues and knowledge is akin to regressing science. The great anxiety seemed to be that research on local issues such as how to improve *bushera* falls outside "the cutting edge" of scientific research. My concern was whether the crisis people face due to the threatened environment, poverty, the threatened survival of indigenous knowledge and culture should be marginalized in the university research and teaching in favor of seeking parity and academic comparability through peer review with the science goals in the North. In Wakki's perspective, "peer review should be turned the right way up: an accountability to people of Uganda and issues important for their continued survival."

With a touch of disappointment, Wakki also drew my attention to what he felt was another serious handicap potentially inhibiting the University's science programs in attending to community concerns in Uganda:

> The other ill in this university is that it offers certain courses and calls them professional, then the others are unprofessional. This is rubbish.

He made reference to the Faculty of Science, pointing out:

> The institute of environment is just botany and zoology now putting on the garb of professionalism, nothing else. Professionalism versus non-professionalism has killed science in this university. We need to address this situation now. Students not doing any aspect of science that is non-utilitarian are just science students. I think this is bogus. Let us all come to

> our senses. Let the professionality be defined by the field. If there is an aspect of Environmental Science that any student of science has interest in, the student should be given the chance. Who knows how a student's scientific mind may be able to utilize any aspect of what she collects from a course for the benefit of us all?

What Wakki conveys here is the stratification, under guise of professionality, that he feels is being perpetrated in the University programs. Wakki uses an example of professionalization to explain the machinations which establish 'insiders' and 'outsiders' as a means of division, isolation or exclusion. For a field like environment, scholars like Braddock, Fien & Rickson (1994) and Wakki's argument expose the need for a multi-disciplinary domain of knowledge which is continually sketched by interdisciplinary discourse. With genuine pain visible in his facial expression as we chatted, Wakki's exhortation is also an advocacy for the conceptual pluralism in the environment in science. He feels that the professionalization of Environmental Science would create the brash territorialization of knowledge typical of disciplinary discourse, a scenario which Ortega (1957) has equally denounced as barbaric because it leads to narrowing of cognizance and curiosity.

Wakki's argument makes a strong point for pluralism because it has the potential to address the complex interplay of global economies and local interests, increasingly sophisticated technologies derived from advanced science and human frailties[16], the use of limited resources within environmental systems and social controls. Objective thinkers like Popper (1979), accustomed to the 'right' way of thinking, advocate scientism; they point out that the practice of conceptual pluralism leads to multiple answers and therefore fails to delineate a clear course of action (Ortega, 1957). In Makerere, Olupot (1995) has noted the rigid admission criteria, based on high grades, to professional programs like BSc (Agriculture) and others. Makerere University could take some advise from Peterson (1994) with respect to the use of standards in admission and program placement:

> The most important question is not the existence of standards, but the meaningfulness of those standards - an issue that must be resolved in practice. The key question is, who is defining the standards and for what purpose. Creating standards at a national level holds particular dangers, given the top-down nature of such a process and... having as much to do with political as educational agendas (cited in Rice and Walsh, 1996: p. 13).

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[16] *Arising from unquestioning compliance or direct marginalization by social or institutional structures (Giroux, 1992).*

Therefore, Wakki's vision is that without attention to the barriers to equity, Makerere University's professional and non-professional program admissions scheme will never compensate for these imbalances. Instead it is likely to enhance the historically and deeply ingrained unequal treatment of students from diverse educational backgrounds. The point raised by Wakki and argued by Interdisciplinary Studies researchers like Fien, Norgaard, and Capra, is critically appropriate at a time when we are concerned about the need for multiple insights and multiple methods to tackle the complexity of social and ecological problems, and the associated difficulties of taking action. Rahnema (1990) brings to our attention the limitations of using a single framework (which, in Wakki's perspective, is predicated by the professionalization of Environmental Science). It is now widely known that such research methodologies have led to the marginalization of women and other social groups; the lack of modification for various differences has facilitated control from a single center of analysis, thus fostering universalization and indifference to context (Schumacher, 1973). What is clear then is that conceptual pluralism which is promoted by open access to discourse promotes participation and decentralization.

5.2.2 Makerere and Indigenizing Discourse

Relegated to science and technology is a trust that it will save people from the (Sorrel, 1992) shackles of "ignorance" and "backwardness". Any change or transformation attained away from a status quo is progress. Capra (1982) identifies the philosophical basis of the secularization of nature as the Cartesian[17] division between the spirit and matter. It is the tradition of precision, prediction and control in the Cartesian worldview that believers in progress see is responsible for moving society, under the hand of historical necessity, toward some unknown but desirable goals. Educational institutions since the Industrial Revolution have acted as agents in this project; one of its missions, as Norgaard puts it, being the advancement of science required to work with new technologies needed to achieve progress. So as Whitehead (1949) noted, the role of a university in the transition from the old-to-new worlds is to be supplier of intellectual imagination in the service of progress. On the basis of democracy, such change is assumed, in this study, to be reflected among the majority. In Uganda, these are the rural masses. I floated a question to Lawino, an Adult Education student and community worker in a non-government organization. This was her view of how Makerere University science programs support the majority of life struggles of the rural people:

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[17] *The Cartesian worldview is attributed to Descartes's picture of the world as a perfect machine, to which Isaac Newton provided mathematical description in his laws of classical mechanics. This theory of reality generated enormous enthusiasm among scientists and the lay alike because of its precision (which allowed prediction) in contrast to the then dominant Judeo-Christian view filled with myth (Kuhn, 1970; Capra, 1982).*

> If anybody really wanted to help them out of their plight the best way would be, you come out of your classroom, come out with your text books, come out with your libraries, come out with your laboratories and go down there - whether you are a social scientist or a physical scientist. You really have to go without your science in the head. You go to learn their science. As soon as you go with your science then you will never help them because they already have a science and your role would be to help them understand how that science could work better for them. What you usually do - you come with your external science which most times is irrelevant to their survival especially, it is also something which is external to them because it may not answer their needs.

In this response, Lawino casts a view that science programs, as pursued in education in Uganda, have failed to make a connection between learning and living. The pursuit of science in laboratories and text-book knowledge is, to Lawino, rather disconnected from the practical realities and problems of the majorities as earlier argued. Like the other voices heard in this dialogue, she does not see science discourse as fostering the predisposition to use the potentials of science and technology in the alleviation of Uganda's social and ecological ills. Some professional scholars tend to hold a different view from Lawino. The thinking of the University academics reflected a view of themselves as part of an already well- established order; nor did they perceive their role as critics of it, or at the very least, actors who have to continually negotiate for transformation. This was explicitly stated by Rigga, another science professor at Makerere University:

> I have little time to spare for your questions because I am dashing for a meeting in town; but briefly based on what you have explained your study to be about, I really do not believe that there is anything useful we as a country can benefit by turning backwards to indigenous knowledge in these environmental issues. Why do you want us go to where we have already passed? What good thing is left of our history? If we do that, no advanced scientist or western country will even look at you. They are not interested in these traditional things. (Then some jesting laughter)

Rigga clearly displays no interest in having science relate to, or re-incorporate some aspects of indigenous knowledge. Nations in the South have tended to treat the industrialized countries in the North with respect and awe as seats of power, knowledge, technology and monetary wealth. Hence it is no surprise that development or progress is measured in terms of methodologies which conform with the industrialized nations' criteria and sense of "development achievements". Similarly, educational discourse – curricula, materials, research and teaching - become prioritized within these Northern models. Fear of reprisal and torment by scholars and other institutions in the industrialized nations is made real by Rigga's remarks, made under an assumption that the identification with indigenous knowledge and the engagement in activities which merge scholarship with the grassroots solidarity is an inferior venture for an academic. The response also reveals an endemic anxiety and fear among some scholars in the South of rejection by peers in the North.

Intellectuals like Rigga tell us that social relations, visions of the future, and the role of education in social transformation must be adapted to the specifications of the industrialized nations. This fear begs a question. What about our ecological systems? Is nature not retaliating as a result of the consumerism and uses of inappropriate technologies like fertilizers, pesticides and polluting industries which are outcomes of patterns of production and consumption we have embraced from the North? Rigga's perspective of science would posit its role as one to serve the modernization agenda which seeks to extract and profit from nature, treating nature as different from humanity, an "other" (Commoner, 1972).

In the views and experiences raised and discussed earlier by the Osukuru elders for example, nature is certainly acting-up. Such a view of nature put forward by the elders portrayed nature as *all that is*, with the primary relation between humanity and nature as that of part to a whole. The apparent contradiction in these views of nature notwithstanding, the sorry-state of the natural systems and of the people in Osukuru and in other places in Uganda merit the attention of government, scholars and the communities themselves. They must seek a critical understanding of why and how the natural systems are retaliating. As pointed out earlier, participatory endeavors seeking to involve science in the solution of these environmental problems could be enhanced by the recognition and involvement of some aspects of indigenous knowledge and skills. Unlike Professor Rigga, Lawino, an undergraduate student, felt very strongly about indigenous knowledge and its value in society in Uganda:

> I think that this is very naive thinking. It is unfortunate that it is coming from somebody who should know better. My remarks are not in any way a criticism. Why should someone from Uganda who is highly educated from a well facilitated university in the western countries - whatever you call them - specialists in computer technology and the like, have his mother, grand mother unable to afford to ride a bicycle to come to town for example? (In other words, how has these people's advanced knowledge helped improve the situation at even in their own homes). So what kind of a advanced knowledge do you do like this?

She gave some examples as to how this could be done:

> One thing which most intellectuals in Uganda have never done and I have witnessed in Latin America, and Asia, is that university professors are committed to the development of their people. You find in Latin America professors accompany peasants to the authorities to demand for more land for the peasants. In the Amazon, university professors fight alongside the peasants against the oppressive policies and programs of the World Bank. When we talk of preserving the people , the environment, we have to do it in similar terms. In this way the university professor is actually offering his service to humanity. Our first task is not to match with any western university, our first task is our people. That is our first responsibility, and this is where we have trouble with university educated people.

Drawing from the above arguments, it would appear that while environment and environmental degradation is a concern among scientists, the scientific approaches to tackling these problems has set very specific limitations. As Rigga's terse response reveals, there has been a conscious effort on the part of academics to exclude indigenous knowledge from this process. Science has failed to take into account the grassroots views, their concerns, perspectives of the environment, their aspirations, and their socio-economic reality imposed by modernization. These views need to be factored into the national development agenda. Approaches such as this would call for what Freire (1995), a development educator, calls a liberating agenda which listens to the concerns of the marginalized majorities, in this case the rural and peri-urban communities, including women. In Freire's view of social transformation, a reversal of ecological destruction needs to be constructed on the empowerment of the grassroots groups with a judicious mix of modern and indigenous science, and driven by alliances among eco-communities whose lifestyle has redefined the priorities, values and behavior in relation to the environment and to other people. These are the foundations of this study's concept of ecoscience.

In the Report of the Visitation Committee to Makerere University College (1970), a section of recommendation (8) to the University reads:

> The new university ... must not be an 'ivory tower'; it must not be an institution to which the lucky few go to obtain an education to entitle them to further privileges; it must not be an institution where foreign ideologies and foreign ways of life are perpetrated; it must not be a sanctuary where intellectuals can indulge in all sorts of pursuits regardless of the wishes and needs of society (p.5)

The character, outlook, and responsibility demanded by the Visitation Committee of the University is that of identifying itself with the aims and pertinent concerns of Ugandans, most certainly of the majority. Lawino saw this commitment as far from being attained:

> I have worked for many years in the non-government organization (NGO) sector. A number of credible NGOs do not recruit Makerere University students or graduates to work in their NGOs because NGOs now think and

> believe that these students or graduates are out of touch with our Ugandan society. I have done several interviews including interviewing Masters degree holders, and have found them unworthy of the job roles offered by the NGOs. Instead we have preferred recruiting 'O' and 'A' level leavers who we have found out have 'touches' with the people. I am very disappointed with this university. I mean, what point is there of producing people who have no touch with the local communities?

Elaborating on the elements of the University's programs that could be responsible for the "lack of touch" with community concerns by graduates and academics of Makerere, Lawino believed that...

> ...because they are somewhere "up there on the academic ladder of the *Ivory Tower*", the others have become *these villagers*. This way the university community has completely stopped to understand what is right and important for this country. I think this university's programs are misplaced - they are not producing to meet our local needs. First of all I think the programs here are such that most people do not even get to know what is happening on the ground. They want to advance as per the West.
>
> Sometimes you find a university lecturer or professor being asked to go and evaluate a rural program, and I feel so sorry for him because they do not even know how to go about the whole process in terms of knowing what is important about rural programs, people's needs and the like. The community, as far as this university is concerned is a very different world of its own; there is a kind of a huge barrier.
>
> I feel that this university has a responsibility which must come out of commitment, and perhaps coupled with a strong national policy, that every intellectual must come out and get out to the communities. I can see change in the rural communities succeeding if it takes a form of 'movement' - you know, for everybody. So everybody must come and go out there and try to change the situation of our environmental crisis and of majorities out there.

Lawino's submission expresses a dissatisfaction with the mere ingestion of facts as an end result of University science education. One problem Lawino exposes here is the oversimplification of an extremely complex social need: that of education, and hence of scientific literacy. An effect of this oversimplification is possibly the ironic lack of urgency some scientists seem to feel when it comes to responding to social and ecological crisis. In Lawino's argument, unless scientists and science educators come to a better understanding of both the potential uses and shortcomings of modern science and technology, the pursuit of advanced scientific and technological power in disregard of the local context will simply lead to further alienation between the educated and the masses resulting in the increased degradation of the environment. Lawino sees a University coached with these critical understanding as a "needed link" towards informed scholarship and action, the nurturance of which should be the university's highest priority. She critiques the incompatibility of the knowledge and its value-base with the realities of the "what" and "why" in the Ugandan social and ecological contexts. This is not to say that the dissemination of new and appropriate technologies and science is undesirable, for they could likely be critical to saving the environment as well as to mitigating some of the created environmental health problems like cancer. What Lawino urges is the need to locate scientific inquiries in education in a broader context, targeting its responsibilities to the ailing grassroots communities and the environment.

5.3 Education, STS, and Environment

In the previous section we examined the views, arguments and insights of scholars and participants on the future of science and technology, and its role in the future of people and nature. We encountered a dominant view of scientific literacy as one sketched by fact-filled and head-drilled scientific principles. We also witnessed voices that challenged this view, arguing that the practice of science in Uganda distances itself from the social reality, and conceives environmental studies as the focus on natural systems' cataloging and characterization, with a goal of understanding how nature works in order to control it.

In this section we step out of the University setting and return to Tororo to listen to the views of some high school science teachers, educators and some elders from Osukuru on their perception of science in education and its role to society amidst an ecocrisis. Most of the dialogue presented here took place during the joint workshop. Mamai, a high school science teacher in Tororo Girls, had this to say about science discourse in schools:

> As a teacher I feel the problem here to be that we are teaching to pass; teaching to be on top of them all. We are therefore not teaching to place whatever is happening in the classroom in relation to whatever is happening outside the classroom.
>
> One of us alluded to earlier, that if we tried to do this, we run the risk of being caught up by time, and nobody will love that, including the students who can even throw you out of the class. This setting is problematic. I think there should be need, in drawing up of the curriculum, to identify our problems, as we are doing now, our problems of the environment. This could and should then form a basis for appropriate pedagogical and andragogical approaches that will alleviate the ignorance and insensitivity which we witness in this country.
>
> We should also in the teaching go out and see what really is happening in the natural environment, and how it can be addressed. It saddens me when a school like Tororo girls is so detached from the surroundings to the extent that when a teacher is teaching about the environment, he has never taken the students outside to see what is happening, and to be able to draw out the solutions to the environmental problems we are facing.

According to Mamai, the school science curriculum is not founded on the service and interests of the majority of the people either in theory and practice. In his opinion, the science curriculum's over-emphasis on an exam-centered learning has deadened students' feelings to the realities that surround them by exposing them to learning routines which are focused on the memorization of abstractions far removed from experience. To him therefore, the curriculum has played a major role in the disconnection of learners from their identity. He continued to express his discontent with the curriculum, saying:

> Even if this teacher made the effort to take the students outside, will he be allowed to say what he wants to say? Our social and environmental situation is so bad that everyone should be made aware of this problem; and that the curriculum be drawn up in such a manner that whereas we are teaching it in the school classrooms, we should learn to go out there, as well as allow the outside to come in. This calls for an example right here. The schools should set an example of what a good environmental quality and practices should be, so that even when people are invited from outside the school setting, they are able to tap-out some aspects of what we teach and apply to their context.

One of the goals of education that Mamai would like to see is an evolution in the conceptual understanding of issues and situations. To achieve this, Mamai would rather have schools engage in the task of developing appropriate conceptions of reality as well as equipping learners with the necessary skills and attitudes for living in this world among other people in various settings. In instilling eco-consciousness among the youth, Mamai's challenge to schools is to set an example by providing children with opportunities for hands-on experiences with living organisms. But a common picture of most schools, which Mamai's account triggered in my mind, is that of ecological wasteland of concrete, gravel and "disciplined" lawns. In some "really good, modern" schools, grass is often sprayed with herbicides and pesticides; trees are cut to be replaced by short-grass lawns which are regularly manicured, all in the name of discouraging the intrusion of anything that might scratch, sting, bite or make distracting sounds. True to Mamai's argument, in our concern about safety and potential litigation, we rob the children of lessons about the natural world that could affect their attitudes in adult life. Responding to Mamai's reflections, Koku, another science teacher from Tororo Girls' School, said:

> I concur with his [Mamai's] reflections. Recently I think there has developed an attitude on everybody who has attended school, who for one reason or another either fails to continue with education and or fails to obtain a job, one would expect such people to come back to their homes of origin and apply that knowledge acquired from school. This makes it very difficult for such people to survive in the very environment in which they have been brought up.

> The tendency has been for such persons to migrate to places they feel they fit better: the urban area. For me I see our school curriculum producing people who are uninterested in living and operating in the actual environment they were raised in, but would rather live and seek work in the urban setting where it is modern, because of failure to apply the knowledge and skills learned in school.

Mamai and Koku both agree on the need for transformation of the school curriculum to catalyze changes in people's perception of nature, cultural roots, and people's relationship with nature. As Carnoy (1980) so aptly points out, much of what we observe about an educational system and about its structure and process is a product of the present organization of production and social class structure emanating from it. To Carnoy therefore, discussion of changes in aspects of the education systems like the nature of the science curriculum vis à vis environmental care need to go in tandem with discussing ways to fundamentally change the class structure of society and the dominant role played by certain groups to control the processes of production and the state apparatus. Loma Bon, a senior academic from Makerere University extends Carnoy's argument in his response to the above participants during the workshop:

> We go back to the story on the ground: the true nature of the World Bank. One of the things there is that the people who drew the picture did not take into consideration the cultural needs of the people; the mythologies, our beliefs of our world, which are the basis of concrete practice in our societies. In the rural places where people like to have children - in fact in a people-oriented society you must have children to be seen to be part of them - for you to try to sell the idea in such settings that, for example, a family should have two or three children does not succeed. Because if the students can accept the theoretical knowledge and actually pass the exam very well but at the same time refuse to identify with the real problems of the people, then there must be something wrong about the foundations upon which the curriculum rests.

This rejoinder has important implications and raises the critical issue of the organization of production in South nations' economies, particularly the type of science and technology used in the "modern" sector and the type of goods being produced. Patterns of production are intimately tied to a transnational development pattern, a pattern whose dynamic center and focus in the industrialized nations is the World Bank (Cardoso and Faletto, 1979; Villamil, 1979). Loma Bon's insights reveal that this agenda for transnational development is not only out of the control of poor nations in the South (albeit its continued presence is clearly due to promotion and support by local groups), but is also a development pattern which favors the dominant groups who support it, to the inherent exclusion of the majorities. In this agenda, Loma Bon sees a reciprocal role of education is to prepare and select those pupils who show the strongest attributes and capabilities for reproducing and extending transnational development. What this means therefore, is that the skills and capabilities needed to innovate for social transformation, environmental conservation and production patterns that are consistent with sustainable development are neglected to the detriment of the evolution of an ecologically and socially responsive science curriculum.

Mzee, a well traveled retiring educator and indigenous to Tororo District echoed similar sentiments:

> The nature of our curriculum is exam centered. From exam, if you excel, you will move along the line and eventually come out employed. So our curriculum is exam centered, excel get employed. Not again to bother about other things like people and environment. So these children who pass through our current curriculum are all exam-centered and employment-centered. That is what they are looking for. I remember onetime when I took students to look at soil erosion. The impression I got from them is that erosion should happen and we are only learning it for marks. So they are only getting this information for passing exams to go to the next grade. Otherwise erosion is not a fundamental issue in itself. The only thing that a student who goes through school will put in practice relates to those who go through technical schools. You do carpentry, good; you can go make use of it. But this theoretical knowledge from our other school curriculum - for a child to go and put it into practice - no! This one is for looking for a (white collar) job. Once you have got the job, that is all.

Koku explained a similar experience with one of his classes, saying:

> I remember myself teaching about pollution. I was teaching the children about the various areas that pollution arises from, particularly to water systems, and to tell them the various ways of solving the problem. We were looking at waste disposal so I took the students to a waste treatment plant. I was displeased with the students' attitude because when we got there, they disliked the smell and were nagging me to get them out of there. It was difficult holding them to listen and gain an understanding of what processes and environmental function the facility does. They want and expect things written on paper. The attitude that everyone has got as far as this formal education is concerned is that if you fail to get a job after school, then you are an outcast in society.
>
> It also works the other way, you see. If one went to school, got education say in agriculture and decided to go back to the rural setting to put in practice one's knowledge and skills, some of the rural people will look at you as a failure-in-life-come-home to share the same fate as those who have never gone to school. So the people we teach do not want to fall in this situation at all. They do not want to be associated with failure; so they make sure that they get marks and pass. In case of failure, one had rather go do anything else than go mix with the rural people.

Mamai supported the above experiences, pointing out:

> Tell me if we in Tororo Girls for example are going to say that cutting trees is not good and yet our school kitchen is using lots of firewood everyday; in fact we use three lorries full of fuelwood a week. Where is that firewood coming from? Hasn't it involved cutting a tree? Do we in this school teach that if you cut a tree, plant three? How many trees have we planted in Tororo Girls? That is the challenge. There is that detachment from environment. Of course there are other factors involved, like lack of funding and so on. I like the philosophy of a learner coming back with something that maybe beneficial for everybody at home.

From their experiences as educators, the above participants' view of the education process is one paralyzed by its own inability to provide leadership through actions that can model ecological stewardship. This failure, compounded by the international agenda of modernization, sends contradictory signals to the youth about what development priorities really are and of the place and role of indigenous cultures and knowledge in that process.

On the basis of these reflections from the workshop participants, it would appear that the school curriculum, like that of the Makerere University, is on a unilinear path which emphasizes theories instead of values; abstraction rather than consciousness; answers rather than questions; and an efficacious ideology of conceptual knowledge and skills in place of a process of conscientization of people in relation to ecological systems.

Vested hopes and trust in education were expressed among the Osukuru elders when elder La Patan shared his view of what it takes to be peaceful and self-sufficient in a sustainable way, in their context:

> One needs to be hard-working; tilling the land to provide for the family. One also needs to send the children to school. When these children complete school, then one is well-established because a child that has completed schooling, say up to Makerere University, will get a good job. This way such a child feeds and sleeps well by his or her choice. Money is assured, and is able to support the problems that obtain at home. Such a child is able to bring home many good (modern) things! The home will not be the same again. To be in government, to be a chief, to be police officer, and to earn money and respect, one must be successful in education. That is what we see everyday. In a home not far from here, the children of a family studied up to Makerere and have jobs. They no longer want their parents to toil in the gardens. They send money to hire other people to do all sorts of chores in their home. They use tractors for ploughing. That is great!

This elder clearly points out how, in the rural setting, they value hard work in their farmland. He also has faith that educating children in these modern times accords them opportunities to earn a living in ways that are commensurate with the market economy. Successful children in schooling who gain employment can help their parents and extended families with the toil of work in the fields, and deal with the pressures of poverty. But he also noted that not all the children successful in education are supportive of their parents and or extended family:

> Some of them do not even appear to like their parents very much. But those who get jobs and do not come home to their parents are those who were not brought up well in their childhood. They grew up with bad social attitudes towards our traditions of respecting and valuing our togetherness.
> Some of such young people are those who are frequently arrested for thefts of government money and property. They even marry from out there and never involve us. Their children do not like to come and live nor visit with us. Yes there are now many of such cases as well. I do not know what to do. Some do not come back because *Kau* has changed. We have undergone a lot of changes here. *Ah*! (Gesturing: I think it is a misfortune)

In his gesture, he displayed an acknowledgment of the presence of contradictions in life today. Kossy shared her women's focus group reflections on the value of education:

> Anything concerning education, we women treat it like religion. Education is something very good. It is unfortunate that many women cannot afford it. The mothers would like their children to read, to study. For us the way we see these men who go back to the village with cars after schooling successfully - it is something *nice*. The kind of life they lead, it is *nice* . So women admire and respect education. It is politics which we have reservations for - given our recent history of turmoil - and the problems which politics has brought. We women do not like that bit of war, killings and so on. we want all our children, boys and girls to study and get good jobs, and make money.

Besides affirming the belief in education as a way to liberation and provision for better conditions of living, Kossy and the other women participants of the women's focus group also expose the male bias in the educational system, career and property ownership in the country. Central to their view is that high literacy rates and education levels are important, especially for women.

Based on discussions shared earlier about population and about women's potential contributions to environmental care discussed later in this study, the consensus was that a woman empowered intellectually and socially can make decisions about a number of children they wish to have and how to manage environmental resources available on a sustainable basis. On the issue of population reduction, they felt that low infant mortality rates would give parents a high level of confidence. Even in a small family, they argued that some of their children would grow to maturity, carry the family name and genes and, in the belief of the indigenous communities, carry the spirits of the ancestors as well as provide physical security for their parents when they are old.

The views emanating from the workshop participants and the elders of Osukuru integrate well with Orr's definition (1994) of a good education - one that measures up to the standards of equity, decency and survival of the ecosystems and people. Orr and some of the study participants feel that appropriate education should guarantee decency and prudence through a dynamic and strong public and or community participation in decision-making and in managing change. As it stands, the exclusion of wider participation compromises democratic ideals. The identification of issues and shortcomings of education has compromised the evolution of ideas and skills needed to make major shifts in personal attitudes and behavior. But as we noted earlier, these inequalities and divergent attitudes are inherent in the nationally advocated and pursued development pattern itself, making the educational system consistent with the social and economic patterns framed under modernization rather than those informed by local needs.

A reform movement in schooling which captures the rights of the majorities and cares for the environment would require the development of resistance to policies which mediate the inherent contradictions of production. Furthermore as Carnoy (1980) argues, development should take place democratically and economically in ways that mass interests are represented, with production socialized under equity, self-sufficiency, independence and sustainability; and which could run participatively (Nyerere, 1967).

In the present setting of the science curriculum in Uganda and its interpretation of environmental education, Loma Bon expressed this concern:

> Curriculum production on environmental education has been seen as the business of certain teachers and not others. Environment is not the issue of any specific teacher. As it stands, it is not the issue of the history teacher, the art teacher, or music teacher. It seen as the issue of particular science teachers. This already is a problem, the way the information is packaged as I see it in practical teaching and so on. In that the school and the policy makers, because they look at themselves as the experts (feel that) those who have attained the degree, those who know *we have arrived*; *we are the people*; feel uneasy to acknowledge and access the knowledge base of the traditional woman who makes *magira* (famous local Teso dish made from cow peas) and has not entered primary one. Such people feel it is a challenge to their school knowledge. So as a result you exclude her. If teachers of science exclude teachers of Arts from teaching environmental issues, then how can these teachers accept people from the village?

To Loma Bon, all education, when measured against an agenda of human and ecological survival, should encompass a model of environmental education which comprehends responsible citizenship. He considers the current practice of exclusive participation in environmental education as having grossly disregarded and misperceived the rich interdependence and interrelationships between people and nature. From this perspective therefore, a model science education which fits into such an alternative view of development would be organized not only on the basis of classroom and laboratory practices but also on socialization processes and the acquisition of skills which are consistent with socio-culturally and ecologically responsive, cooperative and participative forms of work. This participatory component of the model would act as an axis around which indigenous scientific and technological knowledge and a worldview would be centered.

5.4 Some Policy Issues in the Social Responsibility of Science

In his book, *Small Is Beautiful,* Schumacher (1973) made a theoretical exploration of principles of operation for (large) institutions. He not only brings to our attention an appreciation of small-scale operations, but also cautions that 'the right size' is a difficult concept which needs further experimentation and consultation. This critical question of size, scale and modes of discourse has similar implications for science, technology, society and environment and the engagement of these in educational discourse, because these have a profound effect on the quality of life and of human relations especially in times of dwindling resources and increasing population. Without an appropriate framework that integrates these spheres in a reciprocal relationship, hierarchical educational institutions will simply continue to militate against effectiveness and balance. In this vein, Apollo drew from his experiences as a science consultant for a number of national policy meetings. He hinted at some of the problems that arise when trying to motivate science to respond to the public, or even environmental problems, at the policy level:

> Most scholars remain students, and need to be stimulated. So first we need an environment, create that environment which stimulates the mind to appreciate problems. When you look at the water hyacinth problem at Lake Victoria, I remember some of us in various meetings talking to those policy makers and saying: *Why don't we start by looking at the Owen Falls Dam? Because one day, this water hyacinth will reach there.* And this is about three years ago now.
>
> It looked far fetched. Too far for anybody to perceive. But today what has happened? Now it is all over the place. I remember the response to the above suggestion from government policy officials being: *When it reaches the dam, we will just pluck it off.* Now you see the mess there. They have tried plucking it with absolutely no success. Now they are debating spraying it.

Apollo strongly supports science's role in responding to practical needs. His remarks here relate to the poor quality of interaction and low appreciation expressed by government policy officials for science's interpretation and handling of certain social and ecological events and problems. To Apollo, the scientific mind with its predictive capacities can be put to good use in aspects like disaster prediction and control. His example of the water hyacinth accumulation at the hydro-power plant at the Nile is evidence of one such disaster borne out of policy procrastination. He feels that while a scientific mind may not always suggest ready-made solutions, it can see the problem and may even suggest what may be done. He sees the real challenge is the establishment of a framework that could facilitate open dialogue among scientists and government policy makers. Extending these reflections, Professor Mugambi (1992), Dean of Science until 1993, noted in a paper presented during a Regional Workshop on the Physical Sciences in Eastern and Southern Africa that:

> Africa has a large number of technological Research and Development (R&D) institutions like universities but few of these, if any, have made significant impact either nationally or regionally...because these institutions have weak links with national economic planning bodies, poor legal power, weak mechanism for coordinating science and technology.

Both Apollo and Mugambi would agree on this point that policy makers and the scientists themselves need conscientization to develop their appreciation of science's capacity to meet the needs and interests of society and the threatened environment, and to develop the motivation to engage in collaborative and interdisciplinary approaches for tackling these problems.

Apollo's involvement with policy committees has been disappointing, because...

> ...in most cases, we scientists just do not talk. But as a scientist, you often have a wealth of experience behind you. You have visions which can be drawn from other fields and could suggest something which is doable. In environmental problems these days which require immediate and divergent response strategies from society, you find delays in the decision-making process because the other part, the policy makers, do not see the point.

Here Apollo points to the same maladies noted by Mugambi and proceeds to propose some possible approaches:

> Now it would seem to me that acting in small groups in departments, and broadening the approach such that there is greater participation by students and staff in form of projects is what we need to get into. Considering, for example, factors that are impacting on the environment, we should begin asking ourselves questions like: *What is my contribution in this area?*
>
> So I think that we should get in these kinds of studies. The other part that I see is that the developed world, as referred to everywhere, realizes these

> issues very fast and their methods of funding are diverse. They tend to get an idea very quickly, get a few people and they act fast.
>
> For sometime I do not think that it is out of place for a poor country like Uganda to try to seek assistance particularly in terms of funding, equipment, and where needed, manpower, from some friendly nations. We can also try to relate institutions in this country to institutions in other countries and have joint participation in some of these programs.

Apollo introduces a different but related dimension to the issue of dichotomy between professionalism and non-professionalism in Makerere University programs, as raised earlier by Wakki. He sees science's critical position in the wider public domain, particularly in relation to the bigger public institution: government and government policy.

To guarantee the quality of life and of discourse in an educational and political institution, Schumacher's (1973) concept of smallness may be needed to seed and sprout within the motivations and sensibilities of all the participating individuals, for this is where the notion of practical understanding is grounded. The problem of scale, of what is acceptable, useful, and in what ways, lies not within institutions but within ourselves, the people involved.

The concerns raised by Wakki and Apollo relate to an ill-defined area which Wynne (1995) calls the public understanding of science. In Wynne's analysis of the public and science interaction, he identifies the common thread in this science-public relationship as the temptation among social elites in policy making positions to peg policies on facts and figures rather than on the probabilities which science, by the nature of its inquiries, tends to generate. This exposes a number of tensions for the scientists seeking to contribute to policy. As Funtowicz and Ravetz (1990) point out, a common dilemma between science and policy-making arises from the fact that scientists cannot weigh the various uncertainties at different stages of their analyses to the satisfaction of the public policy needs and the demand for certainty. This is aggravated by the increasing complexity of development and the ecocrisis. The implication of these, when tied with statements and experiences from Apollo and Mugambi, is that an alternative understanding of how science can serve society is yet to be devised. Cautioning on the likely effects on environmental quality and the masses caused by the poor interaction between science, technology and "progressive" political thought which is thriving under capitalism, Gore (1992) expresses a fear that politics, politicians and policies are not serving well the majority of people on environmental and development issues, and blames "progressive" politics and policies as running uninspired responses to the environmental crisis. Gore also points out that products of science and technology like television are used alongside scientific uncertainties to manipulate people into a semblance of dialogue, but which in actual fact foster belief in the power of the market and continued advances in science and technology as agents of liberation.

Interpreted within the contexts of the South, the tensions that intersect with uncertainties in science inquiries, the complexity of problems, the interest in modernization, and the powerlessness of scientists to influence government policies and practices contributes to disempowerment. To the South societies like Uganda, these problems are compounded by de-legitimization of traditional or local knowledge, including intuitive ways of knowing. Given the domination of science, technology and decision-making processes by men, the gender and power implications of adopting modernization models in institutions is clear. The dedications of policy-makers and political progressives who support them are framed by the social structures that thrive on the exclusion of the majorities. In light of Apollo's and Mugambi's reflections, it would appear that among those who are socially concerned, only a few see the contradictions between the role of science in South societies' sustainable development, progressive institutional structures, democracy, and the implications for education. These issues present an area for further research and dialogue.

Apollo advocated the need for scholarship to develop a level of sensitivity which nurtures the rights of people and planet Earth. In the University setting, Apollo's view would translate into academic leadership and stewardship in recognizing the need for Uganda, as a country, to invent a future that presents its people with something more than an endless succession of problems to be solved and struggles to be waged. He recognizes internal collaboration as well as constructive external or international solidarity that will support the participatory effort to a way of life that is whole enough to contain crises without being consumed by them. Apollo is therefore acknowledging that a purely scientific or technological mind that lacks an understanding of ourselves as historical, political, social and cultural beings, and of how society operates, is limited in its capacity to serve the larger community. This limited understanding may be responsible for the divisive attitudes among the formally educated and the communities. To Apollo, politicians, academics, and related professionals...

> ...have created an attitude which may be embraced in expressions like "rural technology." With respect to energy, for example, such expressions came, and I am one of the people who feel it should disappear. It is transmitting a signal that rural technology is where you create something on a superficial level.

> I would rather we create an understanding that the people in the rural areas should have appropriate techniques of conducting their activities related to their needs and livelihood in their settings. So we create attitudes. In town you are doing something at a different level, and you say: *this is for the urbanarea.* I think we have got to move away from that kind of approach. For example if you look at bore holes which are supposed to be a technology for the rural areas, to me it is simply a not properly finished product when compared to the running water which we have here in the city, which is also continuously monitored, tested and treated.
>
> In the rural areas no one is monitoring or testing the water quality. These kinds of differentials have created attitudes where we seem to be relegating secondary knowledge to the rural and peri-urban locations. You then have this as a constraint because you have created two levels. One in an urban area gets a finished product -preferably imported from outside. You know that in many countries exported products satisfy certain standards, so the imported products are looked as being superior to the locally made ones of the same function.

The challenge faced by Ugandan academics and various planners is the divisiveness and interception which deters the definition and solution of problems in relation to science and technology. By splitting issues on the rural-urban axes, Apollo sees the application of science and technology being used to enhance social differences. He argues that the use of appropriate science and technology to meet the needs of the majorities living in the rural and peri-urban areas would make a great difference to the people's quality of life. He further asserts that appropriate science and technology should be developed and used within the framework of equity. He also felt that these innovations should be used to meet the life-threatening living conditions of the poor majorities. Therefore, for human and environmental reasons, this essential attention needs to focus on the rural farmers and the women who do much of the arduous work. In Apollo's opinion, the marginalization of this large and important part of the population by current power structures calls for the contextualization of science and technology and its evolution in support of the needs of the small farmer. Given that Uganda is an agricultural country, Apollo's idea could capture appropriate scientific and technological practices that minimize the use of inorganic fertilizers, herbicides, pesticides and other lethal products of the chemical industry. Instead, science and technology could promote sustainable ecological practices such as biological husbandry, which is more environmentally-friendly and locally available to the communities. The same considerations could apply to services such as health care, food storage and processing, nutrition, water supply, credit and marketing facilities, energy supplies, and transportation.

Apollo saw the challenge to concerned Ugandans committed to these changes, as the evolution of a resilience and a strong culture of saying: "No. We have these local materials, skills and implements. They work. They only require improvement." This is where science and technology could make a contribution by evaluating the situation and determining how improvements could be made, in light of ecological sustainability. This process could be implemented without creating differential attitudes that are harmful to equity and sociocultural identity.

It was noted that science in formal schooling was very likely enhancing alienation and attitudinal shift disfavoring rural living. Apollo provided some insights to this point:

> There are many reasons. There is the urban setting with its many amenities which tend to be centralized. When you talk about water, you are not walking a long distance in the urban areas. This water in the urban areas is also tested, since it is tap water, and for many houses everything is right in there, and the systems work well. This awareness is also enhanced by our education. A student may have attended an urban school with all these amenities. Rural schools also make an effort to get water and other basics easily available in the school.
>
> A student will therefore not see any reason for going into the drudgery of village life having had this simple exposure to quick solutions to needs. These are some of the illusions which urban living has created and yet urban living has its own problems. For example, if you do not have money, you suffer greater deprivation than one in rural setting in many respects. In town you need energy or fuel which has to be purchased, while in the rural places in Uganda today fuel may not be seen as something expensive or inaccessible. So these are some of the problems caused by urbanization.

One effect of this situation is a disorientation and disenfranchisement of formally self-sufficient rural people. Giving examples of how this arises, Apollo explained:

> Rural people move in there; often with no plan, and they end up frustrated. The dilemma for one in this situation is that if he gets back to the village, they are scorned as failures. It is also necessary to point out here the fact that it is actually the rural areas in this country which have supported the urban folks since history.
>
> Who grows all the food we buy and eat in this city? Most of us working here have people out there at home; we have land and food plots. We grow food there and once in a while go fetch it. We therefore do not need to buy all the food here in the city. The attitude has to change. We are capable of getting back to the rural people and help in building up what we already have there.
>
> The constraint of funding is also blamable to a large extent on how we organize our society. We have even gone to extent of asking foreign donors to give us seeds to plant for food in the rural areas; and when this system does not work, you now get someone in the rural areas going to the urban

> areas in search of food; someone who has been a producer to come to town now in search of imported food. This may be responsible for creating an attitude of laziness and among some people by living on relief food. So if this continues, our self-reliance which is structurally built in our traditional societies will be greatly diminished or lost in time. These are some of the constraints. They are imposed by our systems which find it easier to request for assistance where we could actually just mobilize our own resources and get going.

The sectarian polarization of Ugandan communities into rural-urban spheres was viewed by Apollo as justification for inferior-superior allocation of goods and services. Apollo is therefore justified in calling for a change not only in the quality of life but also in the thinking among Ugandans which could assure self-rediscovery as a paramount educational and cultural value. Where then does, or should science stand in development as well as in the social and culture-environment interaction? Apuuli, an Associate Professor in a science department at Makerere provided some input:

> Many people think that science has a big role to play in development especially in our traditional home sector. What we can address ourselves to is whether what we're giving our people here in the university science programs is addressing that particular question directly. My answer to that question is: No. I do not think that the training is directly linked to the development of what you would like to see outside. I think we prepare our students in a much broader sense, not just by addressing the specific developmental issues faced by the country. They are instead trained in a broader sense so that they can also address issues elsewhere, not just here. So the training is more universal than just focusing it to Uganda. Certainly as far as needs in Uganda are concerned, I don't think we specifically address the local developmental or environmental issues in the curriculum. Now of course this may be seen as probably an area of weakness, to which I would probably agree. We should do a little bit about addressing local issues. I think this will come in time since we are in the process of reviewing the curriculum.

Explaining how the forthcoming review could cater to considerations for the environment and development, Apuuli revealed:

> We wish to revise our courses, but it's slow process. With the pressure of work on members of staff, we are not able to put in much time in getting this review done quickly. What we wish to see at the end of this review are courses dealing with environment and particularly courses in Radiation Physics. We wanted to strengthen courses in Energy; we want to have a stronger course on Energy Resources. May be also touch on Pollution issues in a course we intend to call Environmental Physics. But it will take us a while at the pace we're moving because of pressure of work but I think we're aware that we need to address some of these things.

In order for science to be responsive to development issues within African contexts, it will require accommodations in its discourse and practice in dimensions such as equity, cultural values, and social and ecological justice. Such discourse must not only recognize the contributions which indigenous knowledge can make, it must also facilitate the active participation of Ugandan communities. Expressing his view in this regard, Apuuli said:

> We should consciously now get involved in some of the issues because I think it's one way to get science to address and get communities to appreciate our contribution to their development. In that sense you'd be making also a science-conscious community. I don't think we've done it. Our present set up is too rigid for that kind of thing. We're the ones to open up and I think the whole Faculty or the whole University should now accept these questions in its structure.
>
> If it opens up that way then you can start many of these courses that are environmentally oriented. I'm sure they'd be very popular if we opened up that way, but the problem is the university would have to be prepared to employ more people because the more you open up, the more you're going to need specialized people in these areas but the whole system is too rigid. We have right now no time to do the traditional things that we're supposed to do.
>
> May be we should say or even look at also the school set-up as equally narrow in its out-look. At the moment every one is especially looking at coming to the level of university education. People everywhere in this country are focused in this pursuit of a narrow educational goal, and it is getting worse. The traditional syllabus is all we want to follow. It's getting worse in my view. I don't know how much you've found out from talking to some teachers but I think we are following a narrow line and it is a dangerous thing.

Current rigid teaching practices practically dictate 'the right way' for people to act and feel, rather than giving them an opportunity to identify what is appropriate for them. It is apparent that an urgent redress of these programs and attitudes is needed. To Apuuli, the task of making programs responsive to socially defined goals and problems was awesome, given that it is the teachers themselves who influence the trends, for they are the agents in narrowing of the path of knowledge:

> Unfortunately practically all of us have gone through the same system. We have more or less been formed like you put concrete in a container and you allow it to set; and for it to be reconfigured otherwise might require explosive forces.

He also agreed that softer paths are feasible, and went on to propose:

> If the universities themselves started following a much wider kind of path then our products made would also benefit from such a system and may be would be able to propagate this same kind of thing. It requires a conscious effort and someone committed to start talking about these things and getting colleagues interested and then you can get the things start moving. It's not a deliberate policy on the part of the department to exclude these considerations. Somebody has to initiate it. I think it would be good but we seem to have little time to reflect on our problems. I think let's admit it. This is one of our major problems in this place. After I leave you now, I will be running to a number of other things having nothing to do with education as such, but vital to my survival, although we all as educators need to give more time to this thing.

His response to a question on how students' research projects are determined provided insights into teaching practices in the Physics Department. He felt that the practices fostered student initiative when students were encouraged to identify the projects undertaken themselves, particularly those linked to social needs. But he also observed that Physics could address the following:

> The tendency has been to give the students a pre-thought out list of projects by staff. We think about the project then say the student shops around this list. This is what is available but I don't think there is anything to stop them actually coming out with their own projects and say "this is what I would like to do. Is it feasible?" and then you discuss it with the interested parties. I don't think the system stops it because I haven't seen it, the few students I have interacted with I don't think none of them I have interacted with has come out with their own project but I think it's something to encourage.

Thus, the science programs in Makerere are potentially very open in principle - projects may be chosen, but few students do choose projects that have applications to Uganda. In a subsequent clarification, Apuuli explained that "universalism" in the teaching of science implies the study of natural phenomena and their interactions. This view emphasized one raised earlier on by Akiiki. In the perspective of Makerere University programs, science - whatever its universal virtues - is pursued as a language of objects, not subjects. It sees scientific inquiry as belonging to the world of empirical fact and practical manipulation, not to the life of spirit nor the ecosystems-people interactions.

Drabe, a physicist involved at the Institute of Teacher Education, also a key personality in educational policy in the country, shared this view of the position of science and technology education in Uganda:

> For a long time we've actually not been spelling out our aims of having any of the sciences in school curriculum very clearly to the teachers. As a result

> all the teachers are teaching to answer questions; *define this*, *explain this* ; *derive this*; but not *apply this* to a situation.

He went on to give a rather embarrassing but typical example of what kind of scientists this form of science education is capable of producing:

> Even the simplest things elude our science graduates. Take an example of the recently introduced Chinese stove. You just ask those who have done sciences. They will not be able to explain how that works. All that they express is *it's just a miracle*. This stove makes use of a thin jet of water introduced into smoldering wood pulp or any shredded biomass. To a scientist, how does water help improve burning efficiency? How do you really get water to burn under these circumstances? Those kind of things our scientists cannot explain. Right now our problem, as most science teachers have themselves expressed, is: *How do we teach sciences for applications*; How do I apply whatever science I am teaching in syllabus to everyday situation? I think that's the biggest problems we are facing now.

The example presented here by Drabe explicitly shows the lack of a tradition of practicality, an unwillingness or perhaps the inability of the science curriculum in the education system in Uganda to ask the critical question "Scientific knowledge for what?" science education appears to have accepted, as its primary focus, the stripped-down cognitive function: knowledge for the sake of knowledge. If science is to capture social and ecological dimensions of discourse, it would require teaching and learning practices which embrace ways of determining and experiencing the basic ideas and skills of science and technology which could best meet society's needs. According to the NSTA (1990: p. 249), this means ...

> ...focusing on real-world problems which have science and technology components from students' perspective, instead of starting with concepts....This allows students to instigate, analyze, and apply concepts and processes to real situations.

Such an effort in science education promises the development of an informed citizenry who are not only capable of making crucial decisions about current problems and issues such as the growing ecocrisis but are also willing and capable of taking personal actions as a result of such decisions.

Drabe shared a personal experience which provided some optimism of how science programs might evolve towards relevance to national needs:

> One of the projects which we had called *Uganda Links*, sponsored by the British Overseas Development Agency, was to particularly address that dimension of the problem. The syllabus was slightly different from the other traditional syllabuses, different from Uganda National Examination

> Board (UNEB) syllabuses in that our topics were things like *physics in the home*, *physics for leisure* and *physics for work*, things of that kind. So that the theme is *what physics do we get in leisure*? So you collect all the topics of physics in leisure and apply it to the particular leisure activities which we're involved in and show what the physics there is. The same thing for the other themes; in fact it overlaps in some of the cases. This project covered mathematics, traditional sciences like physics, chemistry, Biology and then English for the language.

Conceding that there were no specific elements of Environmental Science in the project, its approach has many possibilities for incorporating the critical elements of environmental and indigenous knowledge. Drabe, for example, expressed pride in the success of explaining electronics during the project:

> Originally my colleagues thought electronics to be too high for the college students who were participants. But was so simple. They dealt with logic gates in terms of switches, before they got to the complicated integrated circuits. They used transistors to make OR/AND gates; which helped them to see how transistors have created what we refer to as *digital* in terms of the curves that they can see on the Cathode Ray Oscilloscope (CRO) screen. This takes the physics closer to them because here is the physics they are wearing about on their hands - the watches - everyday and therefore it becomes much more interesting. They are able to interpret what is going on around them.

His opinion was that Makerere University could pursue a similar model in making science more functionally and critically relevant and applicable to the needs of the people and of the environment:

> Members of staff from the School of Education and Faculty of Science should be involved in projects of this kind so that they're able to understand the kind of products of their curriculum. This way they are able to get feedback. I think what they have been lacking is a feedback from their former students. They will have to assess the effectiveness of the classroom teacher in teaching science which has got meaning to the students and not simply science of passing exams which has tended to be the case. In fact the cry has always been very loud from the public. They seem to think that our teachers right now are being driven by examination-performance of their students; and really that is a very big cry. The public has been asking the Ministry of Education to look into that and one of the Ministers of Education promised that he has already talked to UNEB to see how to incorporate continuous assessment which means that the input from teachers should have come in.

The science curricula does expose students to practical work, as is pointed out earlier by other academics, and indirectly here. Drabe's account exposes the tendency of these practices, like the theoretical aspect of science teaching, to be centered on getting students to pass examinations. To infuse greater emphasis on responsible decision-making in education into the real world of students where science and technology are merely components, Drabe would rather see curricula and instructional processes consider their potential to extend beyond classroom-laboratory science to the discussion of problems, issues, and their origins; discussions of alternative approaches to solutions, and potential effects of application of such alternatives on individuals, society, traditional cultures, and to ecosystems. Otherwise, scientific discourse which focuses on quantitative relations between events and objects, ignoring qualitative aspects, reveals and reinforces what Dewey (1960) calls science's construction of control over nature and its sense of reality. What seems to be needed then is a conceptual shift which can free scientific discourse from its current boundaries and expand it into an ecological understanding which encompasses humanity. In Drabe's view:

> This approach should emphasize student participation, where we rely heavily on the application faculties and the skills part of sciences. *Are these people able to make some projects*? *Are they able to explain projects*? *Are they able to explain everyday phenomena, like environmental problems and their causes*? *Are they able to make some implements based on the science concepts they have learnt to address some of these problems*? Otherwise if you don't have that avenue for the teacher and others concerned, we will continue riding science on the track of *define this, prove that*. You find that even the exams are now just content-laden rather than application-laden. Practicals are on proof of theories and laws or identification of specimen and or compounds.

The delivery of science education, through an issue-based curriculum, would likely prevent students from becoming passive observers of the growing socio-economic and ecological problems that ply the Ugandan society as elsewhere in the South. To Drabe, attaining this in science calls for the participation of teachers and students in curriculum development and in issue identification and the development of strategies for building this into professional practice. In his experience, science curricula were developed by experts either in the Ministry of Education or by expatriates in consultation with a few individuals from higher institutions of learning. There was no discussion nor negotiation in light of majority needs or aspirations, as teachers and other educators were merely expected to implement these programs without question. However, on the issue of relating and building environmental considerations into the social responsibility model of science, the need to link science to the community was acknowledged. Drabe, with hesitation, mentioned the recognition and reclaiming of certain aspects of indigenous knowledge which conform to science dominant scientific discourse:

> I see a prospect for involving them, but on the other hand you may find it very difficult to get the rural people involved because of the background. They think that anything to do with school curriculum is for schools and it will soon be a difficult job but all the same I think what we should start with is the teachers, who should begin to identify themselves with the rural people.

The background expressed was two-fold. First, the communication barrier was based on the issue of language; then the historical view of schooling argued that rural people have nothing to do with curriculum. In particular, their knowledge system is "backward", "irrelevant" and unscientific. The Cuban success on school-community collective action in building a democratic society (Morales, 1981; Carnoy & Werthein, 1977) is instructive here. According to Morales, the literacy campaign in Cuba has its historical antecedents in the war against Spanish colonialism whose efforts in education was fraught with high illiteracy and the marginalization of the interests of the masses. In the late 1950s, during the revolution to oust the Spanish dictatorship, the dilemma of illiteracy was tackled through an operation of school networks for children and adults which later formed the basis for the development of Cuban education. The goals stressed the value of science in the economic, social and cultural development and emphasized the need to bring a sense of duty to work, a practice which became a benchmark of Cuba's education during and after the revolution.

An overarching framework of Cuban education became cultural, technical and scientific progress, and the provision of socialist ideological and moral training which became a basis for an all-round education (Carnoy & Werthein, 1977). Based on a strategy of schools and work, Cuban students participated in literacy campaigns by going into the countryside, teaching people to read and write. Later, this campaign took the form of students, at all levels, including teachers and professors, moving out of the classroom and carrying out productive work in various sectors of academic or professional bias while keeping up their studies at the same time.

As Drabe's discussion reveals, the historical exclusion of the masses and their concerns in the Ugandan educational curriculum is an attitudinal problem which conserves status quo and exacerbates the threat to the people and the planet. The Cuban experience provides an inspiration that all aspects of education, including science and technology, can be engaged in social transformation. Drabe's experience working in bureaucratic settings revealed another constraint that potentially inhibits effective interaction and participation of communities in educational program planning and implementation:

> We have very bureaucratic and arrogant officials in education. That is the biggest impingement to the success of getting into community linkages and

> in establishing interdisciplinary collaboration. To overcome it means going through a lot of bureaucracy. There are a lot of people who will start saying *why should we dismantle what we have now?* We could start by getting the people who are concerned with the development of those different curricula in different disciplines take part in productions of some relevant teaching materials. If they take part, if they are also contributors to those articles and practices, then it will be easy for them to start referring to these in their own lessons. When they start revising it, the incorporation becomes easier because you have already got disciples in various disciplines. Therefore they take it much easily.

Drabe is clearly calling for the creation of allies, linkages born out of like-mindedness, commitment and participation. He suggests that most current educational projects located in the Ministry of Education lack the mechanisms to establish linkages with actual schooling. He is calling for structures and project extension into educational institutions that foster continuity in activities and recommendations of such projects. Drabe also saw that accelerating the attainment of these goals would require more resourceful people. The voices of students, scientists, educators, government officials and the indigenous communities, including women must be heard. They must have opportunities for input in the curriculum construction process. He also felt the need for the inclusion of associations as a way to beef up strength, increase the number of voices, and generate a synergy of insights which could infiltrate and challenge dominant views: "There are, for example, no associations bringing together University and tertiary institution lecturers together to exchange ideas. Most of these people who have made any effort in this direction have been acting on an individual basis. What we need now are committed people who can be the resourceful persons to initiate this effort."

5.5 Summary

This chapter has explored views about the interaction between science, technology, development and the implications for the natural environment. Respondents involved included Makerere University science academics; education and environment policy officials; Makerere students, and some high school science teachers and elders from Osukuru in Tororo District, Uganda. Among some of the academics, science was perceived as the pursuit for objective knowledge in disciplinary science. Technological misapplications of science in industry leading to environmental problems like pollution, were seen as a responsibility of disciplines outside of science. Participants who held this view of science also had a strong vision that science and science education re-vamp its curriculum to catch up with the Western models of science, technology, and development.

The understanding promoted by this vision is severely limited because of its separation of knowledge generation and dissemination from the people and their lived experiences. The framing of science simply as an undirected search for knowledge was problematized by some participants, pointing out the likely tendency of this approach to relieve scientists and science educators of their critical responsibility to address the consequences of scientific inquiry and applications of science on the natural world. By abdicating this responsibility and supporting the preference for objective discourse, science becomes an accomplice to the market economy which exploits, manipulates and controls people and nature, creating poverty and environmental destruction (Keller, 1992; Suzuki, 1989). The picture of a pure science, drawn by some of the study participants, is best responded to by Keller, feminist scholar and educator in her review of critical silences in scientific discourse: "... scientific theories impinge on the real, but they do so selectively, not neutrally" (1992: p.89). In light of Keller's comments and those of like-minded participants, clearly, the demand is for a better, holistic understanding of how science and technology work in effecting certain kinds of changes: Why and how have these changes come about? Observations by scholars like Keller inspire the need to make sense of science and technology's workings.

When scientific and technological knowledge is taught as universal knowledge, it focuses on how to do things, how to make things, accumulating facts and figures about how things work and interact. This approach to science and technology education seem far-removed from the forms of knowledge and teaching practices that concern societies in the South: resources, environment, poverty and de-culturalization processes that have arisen over the past post-colonial decades. The increasing importance of scientific information and technocratic order accompanied by the emerging contradictions of technological advances, some of which undercut modernity itself through gross ecological decay, bring to question the science and technology framework upon which Ugandan education and development should be reconstructed and founded.

Philosophers like Ortega (1971) and Arendt (1971) would recommend building evaluative thinking and knowing into the science and technology processes as vital ingredients for the development of skills such as problem-solving, decision-making and ethical judgment which would contribute to socially meaningful development. Evaluative thinking as posited by Arendt and Gasset is a process of seeking 'know-why' to inform the 'what-next' rather than the 'know-how.' As Lazlo (1994) has similarly argued, a person is "developed" not merely in the economic sense, but in the sense of being a mature and responsible citizen. The critical discourse presented in this chapter clearly indicates that our social and ecological survival must begin with an examination of the human factors: the development of the individual's perceptions and actions and their ability to generate and use knowledge for social transformation and empowerment, based on equity and participation.

The realization of a need for such radical change in the perspectives of the University's and school system's science and technology programs in Uganda was seen as arising from the critical question asked: "Knowledge for what?" Otherwise, the objective perspective of science and technology in education will continue to smoothly grease the gears of a mechanistic worldview and bring material benefits only to the chosen few. To most of the participants, this mechanistic worldview and the corresponding science and technology it spawns, is unresponsive to the needs and interests of the Ugandan majority, overlooking the inherent value of indigenous knowledge and the participation of women and rural people in the education and development process. The University's science programs and research activities tend to promote further separation of scientific knowledge from the social realities in Uganda and, in some cases, exacerbate the ecological crisis by emphasizing the 'know-how' instead of the 'know why.' This perspective has also accorded little consideration for the potential contribution which indigenous knowledge can make to understanding and managing the ecocrisis and to the contextualization of science and technology.

Overall, the current concern raised by science academics and policy officials, in the attainment of holistic environmental and socially defined programs, was the limitations of the existing physical plant - buildings, laboratories, research equipment and materials. There was also a genuine concern expressed about shortage of faculty and staff and a lack of funding. It was a moot point whether qualitative relief of these limitations would effect qualitative improvement.

The need for a change in approaches to science and technology in education was sounded by most of the participants who saw the challenge as breaking the traditional modernization cycle and engaging in approaches that link science and technology to culturally useful and meaningful grassroots activities. Such a framework of science and technology in education was seen to require a closer connection between schooling and work, with a greater emphasis among learners, educators, and government officials, on participation rather than personal achievement.

CHAPTER SIX

SCIENCE, TECHNOLOGY AND SOCIETY IN DEVELOPMENT

6.0 Introduction

Science and technology have predominantly been seen as prerequisites to development. Since the Industrial Revolution, such development, bridled with science and technology, has been pursued as a means towards modernization - an escape from the ignorance and backwardness of the 'Dark Ages'. This modernization process has involved the use of science and technology to facilitate material and capital accumulation through natural resource exploitation, transformation, and distribution through markets.

In the same line of argument, state governments of the South nations like Uganda, in need of transformation from its traditional legacy, have been encouraged both by some local and international forces to pursue modern science and technology as a means of revolutionizing their societies towards "development" (Brown, 1995; Carnoy, 1980; Gore, 1992; Redclift, 1984). In this chapter we look at some of the assumptions underlying this development paradigm, focusing on the way in which the agency of science and technology is invoked, or at least seen, as a means to its realization. The chapter also probes into the role of foreign aid in shaping the current perspective of science and technology, and examines some examples of its influences and shortcomings in priority selection.

We will listen to the views of a number of Makerere University academics, some individuals who have worked in government and non-government positions in Uganda. We will also look at some excerpts from the Government White Paper (1992) on Education. Some views are likewise expressed by high school science teachers and the Osukuru elders of Tororo District in Uganda about the national and international perspectives on development and the implications of these views on people's living conditions and environmental quality. Participants also present their thoughts about how education could make a contribution to people-environment centered development pursuits.

The interest here is to explore the participants' views, experiences, and understandings of science, technology and society as mechanisms for change and how the change process is mediated by various interests and power relationships between the society, state, and international market forces. In particular we will share the insights of participants on the state and its facilitation and/or intervention in the use of scientific and technological knowledge for social and ecological interests.

6.1 The State, Science, Technology and Society

As noted by some development scholars, the proliferation of scientific and technological engagements in nation building have taken hold of the developing countries (Harrison, 1993; Brown, 1995). For Uganda, this belief and optimism has led to the demand for educational reforms that emphasize the teaching of science and technology to facilitate the enhancement of maximum creation of wealth (Government White Paper on Education, 1992; Constitution of the Republic of Uganda, 1995). Writing on the vision of Africa in the sixth decade of the twenty-first century, Achebe et al. (1990) expressed hope that African intellectuals and professionals who studied and have remained abroad will return in large numbers, and that locally trained scientists and engineers will fail to get jobs overseas in the future due to their inadequate and inappropriate training for foreign job markets. These authors also express optimism that the growing need for scientific and technological expertise will be an incentive that will counteract the brain drain of scientists and engineers in Africa. The role of these scientists and engineers in the growing industrialization in the region promises a creation of centers of excellence in scientific and technological training research and development. The above anticipations of scientific and technological growth in Africa also provides much potential for what the same authors describe as the demystification of elite-oriented science and technology and also of formal higher education. This, the authors argue, will reduce the gap between both the locally trained scientists and technologists, on the one part, and the indigenous forms of science and technology on the other.

On the use of science and technology to solve common problems, we gain some insights into how Uganda's national programs or project activities are designed and implemented in a manner that promotes domestic internalization of scientific and technological knowledge and practice. Basing his view on various ongoing projects in the country involving the use of science and technology, Wakki, one of the science professors, pointed out:

> We have had water here, we have had scientists and engineers in this country for a long time now. To put the two together so that water can be supplied in communities, we have had to call for engineers from abroad. And when those engineers come here doing the water technology, do you know who are working with them? *People who cannot even write down the equation of water flow!* Those who should be interested and can interpret the technology are not there! Next time we want a gravity-water flow project in the mountains, we have again to call one of those guys from abroad. Look at our roads. A lot of money has been spent in this country hiring international constructors on road building. Our own technical people are either in the office looking at "paper work" and so on, or simply inaccessible. The people who are taking measurements, taking decisions as to whether they should blow out some rock on the way, destroy part of a

> forest here, fill-up a wetland there and so on, are not our people (Ugandans).

This reflects a concern for self-reliance: the local continuity of science and technology among Ugandans, and accountability in the use of science and technology vis à vis their impacts. Faith in the evolution of an African strategy for self-reliance based on science and technology, as earlier noted from Achebe et al. (1990), is sharply brought into focus by Wakki's statements above. We also note the need for such an evolution of science and technology to be grounded in an alternative understanding of the African condition vis à vis modernization. As Samoff (1996) has argued, such alternative understanding of science and technology in development requires a firm sense of context, in particular the links between underdevelopment, global restructuring based on a global market economy, poverty, aid dependence, loss of vision, and educational crisis.

In a determined effort to develop national-based scientific and technological activities, Wakki is concerned for Ugandans to become actively involved in scientific and technological projects as an insurance against becoming victims of the consequences of such projects. A common feature described by Wakki is the employment of foreign experts in the majority of construction projects in Uganda. The multi-million construction of the Mandela Sports Complex near Kampala city and of the extension of the hydro power plant at the source of river Nile, Jinja are visible examples of construction contracts funded by World Bank loans and held by foreign companies in which participating Ugandans are relegated to the level of laborers, or at best, technicians. At these levels of participation, Wakki sees Ugandans being unable to make influential project decisions on issues related to its impact, saying:

> Why shouldn't students in university be involved in our civil engineering or technical industries? Why can't government decide that they be involved in these projects? Are we able to say: *there was a very big problem in the localities of Kireka and Bweyogerere and the engineers decided to block the swamp*. No participation at decision level means we cannot justify and explain the consequences of project actions in light of the local and community needs contexts that relate to the swamp besides the technical justifications. In our case, who are making these decisions? They are not our people! Is there a future for science and technology in this country?

Wakki believes that the low involvement or non-involvement of Ugandan engineers and scientists, including students, on ongoing projects which directly apply science and technology, like road and bridge construction, is a failure to prepare Ugandans for the responsible applications of science and technology in ways which also foster independence or collaborative partnership with foreign experts.

An important dimension we could add to Wakki's concern over the absence of local scientists and engineers in such foreign-funded projects relates to known examples of deliberate exclusion of local expertise from such "development" projects which critics associate with problems of development aid. World Food Update (1993), for example, points out that the financing of most development schemes in the South is often tied to the recipient nation money which is used to hire contractors or consultants from the donor country -- an arrangement called tied aid. In science and technologically-oriented projects, as in others, such an allocation of development assistance has very little to do with the support of social transformation and capacity-building of the societies in the "underdeveloped" nations.

Wakki's query as to why the Government does not ensure the local participation of Ugandan students alongside the engineering and science community also highlights policy implications which we will discuss shortly. But the other dimension of Wakki's statements partly exposes his view that a perspective of how school knowledge relates to social issues certainly plays an important role in equipping people to solve society's problems.

Wakki's alarm over the crisis surrounding modern science and technology in education and its impact on the future of Uganda is not an isolated one. It is not only outsiders who bear the blame for the lack of local participation in applications of knowledge to local contexts. As earlier mentioned, some local elite groups for a long time have had a hand in shaping the course of events in the South nations, independently or in concert with foreign powers. In his address to Makerere University students and faculty (1991), President Museveni of Uganda had an unsparing view of education and its transformative role in the South context:

> Africans are not intellectually independent; they are not ideologically independent. They are intellectually lazy and the salvation for a lazy man is to imitate other people's ideas because he does not then need to think for himself. You abdicate from thinking and copy what other people are doing irrespective of whether or not it suits your circumstance: this is our biggest crisis... It is pathetic to see that the so-called African intellectuals are completely incapable of original analysis and appreciation of vital issues. (p. 10)

The serious concerns raised above have also been justified as being more "rational" than traditional societies Waber (1947). But as the Osukuru elders had earlier noted, the establishment of modern bureaucratic institutions has made little or no provision for dialogue on what affects them. "Democratic freedom" thus in practice becomes an elusive reality to people who cherish independence and autonomy (O'Donnell, 1973). Such failures of bureaucratic institutions and processes are well-explained by Abrahamsson

(1977) who argues from a Marxist perspective that bureaucracies are established to serve the interests of particular groups or classes not the public.

On the basis of the above, there are enormous implications for the need for a transformation paradigm that cuts across the whole fabric of government and its institutions. For example, in programming the discourse of science and technology for national development the challenge particularly falls on education and government policy makers to jointly ensure that science and technology in education are socially and ecologically contextualized. This requires that policies that would allow science and its technological applications to capture responsibility and accountability to the threatened ecosystems and to encompass the needs and participation of the majorities.

In fine-tuning science and technology to respond to local demands, Kumar (1987) provides a useful premise. While the laws of science are universal, its applications in the form of technology affect different countries in different ways. An example of this concern surfaced over modern Food Science as it is currently taught in schools. The women's focus group discussions in Osukuru raised concern over how modern science has influenced young school girls to abandon some of the traditional dishes and ways of cooking:

> Some of these girls, like the daughters of my sister, can only cook if there is cooking oil from the shop. They do not want to use our clay-pots. They demanded their parents to buy a flat sauce-pan so that they can fry their food. They want to fry everything with Kimbo (industrially processed cooking fat). This is very costly for their parents. Their mother is always complaining to them about their need to cook local dishes.

Food Science and Technology is one of the programs which the Ugandan education system put in place to harness modern science and technology in food processing for the market. From the above analysis of the women's discussion group, while the Food Science and Technology program in schools and a number of institutions of higher learning hoped to equip Ugandans with the necessary skills to solve their problems, the experience of the women in rural areas sees the strategy as a problem rather than a solution. Three issues can be drawn from the rural women's comments on the science and technology education program in schools. First, the program demands for inputs which are exogenous to the cultural milieu in which the students live and hence is devoid of the social realities. Second, it alienates students from their traditional roots; in this case, from indigenous diets which are based on the products of subsistence production. Third, the modern school science program introduces and imposes requirements and processes which are embedded in a modernization paradigm which breeds dependence on market forces.

In a related analysis of modern science and technology and its potential to benefit their indigenous community, elder La Patan pointed out:

> Our water system here is very poor. We have open traditional surface wells, but the water no longer tastes the same because of the fall-out from the cement factory. The fertilizer factory, now closed, also used to shunt their waste to this swamp. I think our sickness and disappearance of animals and plants in this area is due to chemicals from these factories which have spoiled the water. We have few latrines. Peoples' waste during rainy season also goes down to the swamp, and gets to our only source of water. We would appreciate if we could be helped with piped water from the river which might be safer.

To La Patan, science and technological applications which would help them to develop the skills and conceptual knowledge for surviving in a polluted environment would be useful, including the provision of water supply, sanitation, and aforestation. The laments shared here illustrate some of the effects of an uncritical adoption of science and its technological ramifications by most nations in the South in their hope to follow the pattern established in the industrialized nations.

As Schmandt and Katz (1986) have discussed, science and technology define a large part of what gets taken for granted and point out a need to "continue to change our system of governance, the nature of issues policy makers deal with, the role of government in society, the responsibilities of the citizens, and meaning of such concepts as liberty, political accountability, and democracy" (p. 40). For science and technology in developing nations, this means a continued revisioning of the meaning and purpose of development based on the internal priorities of the majorities.

6.2 Development Path

Development or progress[18] has been the focus of much attention in national planning in South countries. The history and beliefs of progress are often closely tied to both Judeo-Christian beliefs and to the proven accomplishments of Western science and technology (Nisbet, 1980; Norgaard, 1994). The contemporary ideas about progress may be considered, in the historical context, to be earlier ideas regarding what development is. Having survived history, they became rarefied through the evolution of ideas and events (Burns, 1980; Norgaard, 1994). This historical link between progress and development referred to by these authors provides an area of tension among individuals and cultures arising from a clash between the old beliefs and the new ideas based on contemporary events and experiences related to development. As these scholars and others point out, little effort has been made to seek a critical view of the concept of progress within the perspective of indigenous cultures. It was the interest of this study to explore views from a rural community in Uganda, and among other Ugandans, about the impact of modern science and technology on indigenous patterns of life, including that of the environment.

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[18] *Development and progress are used here as partially overlapping concepts. Development is a more recent term of the two gaining its prominence from 1949 when US President Truman established criteria for development, "developed" and "undeveloped" nations; making development to be associated with specific instrumental concepts. Progress on the other hand has a longer history and is associated with general beliefs about goals and processes (Burns, 1980; Nisbet, 1980; Norgaard, 1994).*

In an effort to gain insights into dimensions of these tensions in the African context, I asked Zungu, an expatriate professor at the Faculty of Science at Makerere, his views on the relation of development and the role of science and technology in this process. With a strong sense of conviction, he responded:

> If Uganda is going to develop, it means it is going to industrialize and so you change your situation from a situation where 90 per cent of the population are agriculturists to a situation where 10 per cent of the population are agriculturists. I don't think you should project into the future under the assumption that the lives of the people are going to stay the same; unless you want to doom Uganda to remain a developing country forever. If you are going to develop, development means change and change is primarily where wealth is generated through industrialization and not through agriculture. For countries in Europe and North America -- about 2 per cent of the GNP comes from Agriculture. So if you want to develop, that is not the direction to go. Although it is true that there will be many of these very pressing problems for a generation or two, at least we should also be looking slowly ahead more than that to a very different way of life that eventually you will be living.

Zungu expressed a strong conviction here that Uganda's current dependence on agriculture as a means of production will not liberate its people from the chains of poverty under the global market forces; and sees industrialization as the only hope for creating wealth, or economic liberation. He bases his argument on the experience of the industrialized nations where the ratio to GNP[19] of agriculture is much lower than that of industrialization. In our examination of assumptions of development, Zungu's response identifies the needs of Ugandan society for development as achievable only through modernization - that is, the transformation of traditional societies into modern ones, characterized by advanced technology, industrialization, material prosperity and political stability.

Contrary to Zungu's perception and prescription for Uganda's development, the elders of Osukuru had this to say about development (*akerianut*):

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[19] *Gross National Product: the total value of the goods and services produced by the residents of a nation during a specifies period (usually a year) (Merrian-Webster's Collegiate Dictionary (1994).*

> *Naasodit, ejai amio. Emamei akerianut arai amamei amio. Amio nges ajaut ka lup; ere; idwe; ateker; ajaut kibaren kon; k'akoru inyamat luedolitos; aijar nailajaara; naejai angaleu;kopiding kon* (Elder La Patan); *karicite ateker kalu awoliosi da . Yen ericit nu amio nges ejaasi ka kerianut*. (Elder lady, Dikko).

> First of all, we have *amio*[20]. There is no development without *amio*, which requires having a culturally-based family with land and a home; a clan - its values and artifacts[21]; domesticated animals; and self-sufficiency of food from the land; good health of all including the land (Elder La Patan); taking keen care/preservation of the clan, of the ancestors. Pursuit of these on a sustainable basis is to be developed (Elder lady Dikko).

The view of "development" which the elders presented has an organic link to their sociocultural milieu with a strong participatory and interdependence element, cultural beliefs and spirituality, and to the quality of their land. This view, quite strongly expressed, tended to contradict their support for modern education and the perceived 'good things' it will accord their children and families. Their explanation of this apparent contradiction was that, as parents, it was their duty to provide their children with the best possible options to survive in the market economy. However, they were quick to point out that government jobs are not forever or not for everyone, meaning that their children still needed an understanding and internalization of the cultural dimension of development when they retire back home.

The views expressed here differ sharply from those of Zungu who assumes a universal view of what development and social change should be (Hobart, 1993; Brown, 1995). In its idealization of the main direction of certain social and cultural trends, Zungu's assertion of what development is absolute-referenced to the supposed "modern" state of the dominant industrialized world. So progress, as a process to the attainment of development, means an unwavering pursuit of the western scientific knowledge, lest Ugandans get it wrong. Prescriptions for development as posed by Zungu are based on a modernization model which ignores some very strong cultural perspectives to development. Such a transformation from traditional, subsistence-based production to "modern" market-based lifestyle would present some serious caveats for the majorities who still live off the land. First, the shift to industrialization by a society like Uganda is a recipe for the dissolution of potentially achievable sustainable traditional life into one of dependence on dominant western science and technology. It means the traditional cultures must yield to the homogenization and commodification of urban lifestyle by buying and selling. Second, the lumping of heterogeneous activities of indigenous societies and their conversion to labor to serve modernization ignores the cultural discontinuities and differences that arise in the deconstructions of cultural meanings of land, labor, the organization of economic decision-making, and the idea of economy itself (Tribe, 1978). Third, the merits of science and technology notwithstanding, the knowledge and practices involved, when applied to development, are not neutral because modernization treats culture and society as an 'object', and hence an obstacle to change, never a facilitator of change. Fourth, there is the fundamental question of Zungu's modernization prescription that overlooks its underlying assumptions about equity and justice. Modernization, as most scholars have argued, makes gross assumptions not only about the trickle down of benefits to all and the structural violence to people, particularly marginalized sectors, the economic under-classes, and minorities, but also accepting the exploitation and inevitable destruction of the environment by the dominant and exploitative power structures (Toh and Cawagas, 1989; Shiva, 1992; Carson, 1962; Adams, 1993; Merchant, 1980).

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[20] *The closest translation of* ***amio*** *is self-sufficiency, capturing sustainability, but has a strong cultural element of having all dimensions of identity embedded in it. For example, having millions of money in this view is not* ***amio****, but* ***abar*** *(transient wealth).*
[21] *These products of human art include various cultural devises which are a product of indigenous science and technology.*

When probed about his modernization proposal for Uganda to modernize in light of the aforesaid caveats which were reflected in the social and ecological changes and issues in the industrialized countries, Zungu clarified:

> Well, people would all like to be better off. And especially they would like their children to have a better life than they have had themselves. So that is a driving force. It is paid employment which makes people better off. And even now I am sure that a number of people in paid employment in Uganda is probably doubling every ten years. At the moment the population is increasing at around a similar rate and, but not so fast so the proportion of people in paid employment even if he is self-employed, the guy who walks around selling clothes in the street, I mean he is in the cash economy, and the proportion of people in that situation is increasing with time. This is the way in which people will get better off. You won't get the population as a whole - will never get rich from agriculture. It is not possible. That is not to say that farmers can't be rich. I mean farmers in Europe and America are rich. In Britain, for example, only half of a percent of the population are farmers. And that provides almost enough food for the other 99 per cent. In fact, one man farms five hundred acres, and produces a thousand tones of wheat.

Zungu had a strong view that a shift from a traditional economy to one based on market is the surest way to give every Ugandan a chance to compete and attain some level of monetary and material affluence. He sees the traditional mode of production and people's struggles to make ends meet amidst dwindling natural resource base as playing a losing game against the growing market driven global economy in which competition within the system offers one the best opportunity for "success." Such success in harnessing science and technology towards modernization of economies has been achieved at a heavy price which Kumar (1987: 73) clearly describes:

> The rapid advance of science and technology in the last decade has undoubtedly contributed to the emergence in developing countries of two crises, in development and [in] the environment. Poverty and landlessness have worsened in the Third World, while economic stagnation has also been a problem in many countries. The environment has been steadily degraded, while there continues to be an inadequate understanding between science and technology, economic development and environmental conservation.

The message here is that the current process of modernization has not only failed to meet the basic objectives and expectations of economic development like the eradication of poverty or the provision of employment which will facilitate people's capacity to meet basic needs; it has also destroyed the environment.

Zungu's proposal for the development of Uganda has a binary argument: if farmers in Britain and America are rich, why can't the same be true of the farmers in Uganda? It is because, in Zungu's views, they use primitive and small-scale methods of farming. He also endorsed the use of high technology, fertilizers, and monocropping which is scientifically managed. What Zungu does not say or realize is that large subsidies are given to farmers in the industrialized countries by their governments; and that there is manipulation, exploitation and coercion of cash-crop farmers in the poor nations by both the local governments and the transnational corporations and national bureaucracies in both the rich and poor nations (Redclift, 1984; George, 1976; 1987).

Zungu's vision of industrialization as modernization does not sit well with the Osukuru elders who expressed their vulnerability arising from the industrial development in Tororo. To them, industrial development in Tororo legitimated and thus enhanced deforestation, pollution of air, the fresh-water source at their swamp, and general vegetation. Elder Dikko would have no defense for industrialization:

> The best of us and our land has vanished because of those factories. What good life is left here? (*Inyo nat bobo ejai ne?*). When government came to build those big factories of cement, fertilizer, asbestos and the one they used to mix *dudumaki* (DDT) just near the fertilizer factory; we started experiencing problems here.
> We do not feel secure here. When governance came upon our land, we started experiencing these problems. It is government that established the factories for cement, fertilizer, asbestos, and the one they used to mix *dudumaki* just near the one for fertilizer. Now there is the Uganda Steel factory. The gases, dust, liquids, and other solid wastes that come out of those factories have led to the tiring *(aitegakin)* of everything we depend on. They use very dangerous chemicals *(ikee lueroko noi)* of different types imported from abroad. I am sure these chemicals *(ikee)* should not get into

> our food, water, air or onto crops and land. This is why we so much death here, of everything. Those factories.

Dikko's narrative ties with those voiced by elder La Patan and his concerns for appropriate science and technology in redressing the damage done to the ecosystems and people's lives. In Zungu's antidote for 'underdevelopment' communicated earlier, and what the voices of the elders revealed is the unnoticed tensions and deep attachments among the people in their enclaves of rural communities of Uganda to the land itself and all the life it has supported. What Zungu's model of modernization factors-out is embedded in Dikko's latter statement. That is, besides the social and cultural relations of the traditional communities in the countryside, there is the ecology of human relations with the land: this is an interaction which cannot be treated as Zungu would see people treat mechanized food production or industries or cash.

In her deep reflection: "The best of us and our land has vanished because of those factories. What good life is left here?" Dikko delivers a message that for them, the earth is not merely a factor of production as modernization would have it; the earth is a living thing that makes an ethical claim upon their loyalty. Dikko's message floats an indigenous sense of identity which is organically woven into the land's history that she (the land/earth) has generated them out of herself, nurtured, shaped and sustained them. With the ecological changes ushered by factories at their midst, the web of life has been severely damaged.

Advances in scientific knowledge and adoption of technologies from the West have so enamored developing nations that they are significantly having numerous unforeseen and unfortunate consequences (Brown, 1995; Harrison, 1995). To Neitschmann (1987), one of the most disturbing consequences of the Western vision of progress is the waging, by numerous developing nations' governments, of campaigns against their own traditional or indigenous peoples, rationalizing their state power-driven actions as a way out of backwardness. Within these conflicting views by Dikko and Zungu about the nature of progress and the place for environmental conservation objectives with a view to sustainability, Zungu argues:

> The main problem is that people can't really put any significant resources into trying to preserve things no matter how much they have enough of it. To the peasants, the question is: *Does it help to feed the family tomorrow*? That has so far for everybody's concern for the last twenty years. But as people get richer they do have surplus energy - hopefully. You do notice people are putting more effort into recreation, going for picnic, family weekend or something. Which shows they have got spare energy beyond the mere effort to survive. When you greeted people ten years ago, the normal greeting was "How are you surviving?" or something like that. It is less so these days. People don't always admit it but many people are much

> better off than what they were ten years ago. I know the vast majority are not better off, but some are. Look at the traffic jams in Kampala - if you want any evidence of that - vehicles have increased dramatically just within the last two or three years. And the number of people who travel in taxis these days is quite incredible. You can get half a million taxis in Kampala, and all those people are paying a minimum of two hundred shillings. So there is beginning to be a little bit of surplus on the population. People are better dressed.

The material increments often observed in Kampala city are generalized into not only the other parts of the country but also seen as sustainable into the future. What Zungu has raised about Kampala has some truth to it. The streets are choking with cars; the city center, shopping malls, and markets are adorned by well-dressed, healthy looking business men and women selling and buying. But there is a downside to this reality. There is an increasing number of beggars, street children, prostitutes and ensuing street violence. The back alleys of downtown and slums are a sorry site of poor waste disposal and of people practically living off the refuse: a form of informal waste recycling industry reminiscent of modernization. Suzuki (1994) shares these concerns particularly about cities, which he describes as growing explosively in both the North and South. In his analysis, Suzuki notes that while cities offer an illusion of a better life, for most people they also increase alienation, family breakdown, violence, and drug abuse. Similarly, authors like Coles (1981) describe how the structural injustices of modernization has evolved cities congested with millions of people and helpless women and children living in abject poverty. Overall, the pollution of air and water in these cities also poses an ecological burden on the planet's life-support systems.

Perhaps having spent little time in dialogue with the rhythm of life in the indigenous setting -- the seasons, the land, and the presence of the 'wild things' that has defined the feelings expressed by the elders of Osukuru -- Zungu has no alternative foundations to challenge his conviction of the desirability of urbanization. As long as the city shows a semblance of happiness advocates of modernization are satisfied to attribute these superficial images as indicators of "a better life". Viewed in Zungu's perspective, modernization enriches life as no other social form probably ever has. Zungu's view certainly thrives on the culture of urbanization-as-modernization: a form of urban imperialism which, to Roszak (1978) and Giroux (1994), is bred by intellectuals who need and use cities for limitless inquiry and creative experimentation, giving them and their city havens the monopoly over the means of cultural production and distribution. With the powers of articulation and persuasion getting more and more concentrated in the city paraphernalia: press, media, educational institutions, the sources of information and research, the concerns of the non-urban majorities and of the environment could become further removed from the "objective" intellectual discourse.

The voices of the Osukuru elders could point out in Zungu's statements a sense of detachment reminiscent of a rationalist scientific worldview -- that of the detached observer. This conception of knowing and acting has significant impact on the relationship between science and society due to its being filtered in terms of "objectivity", rather than on the basis of responsibility and accountability. These ideas on objectivity hinge on the subject-object or primary-secondary qualities distinctions elaborated by Galileo and Descartes (Popper, 1979; Pepper, 1986). The obvious shortcomings in the assumptions of objectivity are well elucidated by Russell:

> Unlike religion it [science] is ethically neutral: it assures men (women) ... can perform wonders but does not tell them what wonders to perform. The philosophies that have been inspired by scientific technique are power philosophies, and tend to regard everything non-human as raw material. Ends are no longer considered: only the skillfulness of the process is valued. This is also . . . a form of madness (Russell, 1946 - Quoted in Pepper, 1986, p. 61)

However, Russell's label of "madness" to an image of a detached scientific view of things would be, in the eyes of Bacon, "heroism" (Jonas, 1974). Bacon saw science as leading to an utopian society in which all human needs would be met through the conquest of nature using science and technology. Underlying this Baconian vision shared by many more people today is the concept of steady progress propelled by increasing mastery of nature, which is the result of knowledge gained by scientific inquiry and corresponding application of technology as advocates of modernization would point out. By enshrining this principle into the national economy, all countries, poor and rich, go in for (1) advancement through economic growth; (2) commitment to the use of advanced science and technology, and (3) making trade more and more internationally competitive (Elgin, 1982). For a poor nation like Uganda, such a rationale is seen as the best and probably only pattern of development. This framing of development is attainable through production processes which essentially relate to (a) reorganizing people, like moving them from villages to cities to work in industries; (b) either extraction of resources from the ground like minerals, oils, big-scale intensive agriculture, or synthetic manufacture of plastics, clothing and other products from natural resources or from other industrial byproducts. "High-tech" production with machines, chemical inputs into the environment, and biotechnology have evolved, as examples in most industrialized countries show, as aspects of development, the indicators of which have stayed pegged to scientific and technological innovation. In the analysis of these technologies scholars like Shiva (1992), Suzuki (1992;

1994), Capra (1982), Berry (1988) are open about how the spread of science and technology has created a uniform, highly consumerist culture across the world. This uniform culture is also pointed out by these scholars as dividing people by creating disparities instead of integrating them. The analysis of these scholars confirms the narratives of the elders and other participants, decrying the development processes which have led to vast quantities of natural resources being used to maintain the small minority as beneficiaries, while poverty and malnutrition are rife among the majorities in rural and peri-urban settings.

The flip-side of such improvements in the human condition as transportation, better health care, better living conditions and others, brought in by modern science and technology not withstanding, has more to do with who benefits and who does not. The mismanagement of natural resources engendered by the current pattern of consumption is an issue of contention vis-à-vis development.

In Uganda, the strategy for sustainable development and environmental conservation is articulated both in the Constitution of Uganda (1995) and in the White Paper on Education (1992). According to the Constitution, the State shall organize and empower people

> ...to build independent and sustainable foundations for development (Objective V(ii) p. 3);

In order to facilitate equitable development, the State shall

> ...encourage private initiative and self-reliance
> (Objective IX p. 4).

The role of the State in this development agenda is pointed out as that of giving...

> ...the highest priority to the enactment of legislation establishing measures that protect and enhance the right of the people to equal opportunities in development (Objective XI (i) p. 5);
>
> Stimulate agricultural, industrial, technological and scientific development by adopting appropriate policies and enactment of enabling legislation (Objective XI (ii) p. 5).

The guiding policy statement on protection of natural resources expresses the role of the State as that of...

> ...protecting important natural resources, including land, water, wetlands, minerals, oil, fauna and flora on behalf of the people of Uganda (Objective XIII, p. 5);

> promot[ing] sustainable development and public awareness of the need to manage land, air, water and resources in a balanced and sustainable manner for the present and future generations (Objective XXVII (i) p. 9); and
>
> promot[ing] and implemen[ting] energy policies that will ensure that people's basic needs and those of the environment are met (Objective XXVII (iii), p. 9).

The Constitution also identifies the State's role in the creation and development of parks, reserves, and recreation areas to ensure the conservation of natural resources and to safeguard of biodiversity of the country.

The Ugandan government White Paper on Education (1992) has made recommendations on both the creation of awareness to foster environmental conservation, as well as the expansion of science and technology at all levels of education for the reason of creating plentiful national wealth, or capital accumulation. The two documents are consistent in their proposals for both environmental care and for scientific and technological advancement to promote economic development. Ugandans, empowered by a new way of thinking brought about by the National Resistance Movement (NRM) government whose ideals are well reflected in these documents, can without question succeed in an all-out effort to save the environment as well as meet some of the development goals. But this effort will demand an even deeper understanding, besides respect, on the part of all Ugandans including government, for the political and economic freedom of individuals. As a country that considers itself free, the emphasis on the rights of the individual and of private corporations may need to be accompanied by a deeper understanding of the responsibilities to the communities vis à vis the environmental question. This is because rights to development should involve, as Fowler & Mooney (1990) argue, a balance between rights and responsibilities. As the accounts of the Osukuru elders on the impact of industrial development on ecological and social environment in their locality have shown, an imbalance between individual/private enterprise rights can tilt rights away from any sense of obligations to the welfare of the people and the environment. The United Nation's Sub-Commission on Prevention of Discrimination and the Protection of Minorities (1994), in its draft report, upholds the need for people to have the right to an environment adequate to meet equitably the current needs without impairing similar rights for the future generations; and that persons have the right to protection and preservation of the air, soil, water, and other forms of nature's creation. Equally strongly recognized by the Sub-Commission is the right of indigenous peoples to control their lands, territories, and natural resources, and of protection against any action or course of conduct that may result in the destruction of these territories. The recommendations in the White Paper to promote science and technology in education for purposes of development will find compatibility with its equally strongly proposed goals of environmental conservation by taking some caution on the basis of what Capra (1982) advocates as an overall change in science and technology education at both conceptual and operational levels in order to capture socially just and ecologically sustainable practices (Fien, 1990; Huckle, 1988). Capra argues the need for the educational goals in science and technology education to be related to personal, social and ecological needs if the education is to improve the ability of individuals and groups to cope with the challenges of modernization that have been realized through advances in science and technology. A challenge for Uganda lies in the evolving strategies of development/industrialization which use science "to develop technologies for humanity and the environment" (Kumar, 1987: p. 80); such programs need to foster the participation of the majorities, with a stronger emphasis on the roles of women and youth as equal partners in education and development.

So how can science for development of Ugandans assure that indigenous Ugandan interests and participation is an integral component of its building blocks? Zungu said:

> In Zoology and Botany, there are people working on Ethnobotanical projects. In Zoology we have people looking at animals ruining their crops, there have been a lot of people looking at land-use problems using the Geographical Information System (GIS) and remote-sensing analysis, and understanding patterns of land-use regarding how people are living. People who do this kind of analysis go and spend a lot of time in the field with villagers. Our scientists go around with their questionnaires and they do their Participatory Rural Appraisals and that kind of thing. So there is already a fair amount of that activity and it is growing.

Zungu's explanation above relates to some positive uses of science and of the experience and skills accumulated by scientists in helping solve some aspects related to the ecological system. As a cataloguing devices for ecological destruction, the GIS/remote sensing techniques increase accuracy and speed with which data on deforestation and other biodiversity distribution can be collected and analyzed, easing the task of planning of mitigation strategies in environmental resource management. Crucial in these environmental inquiries and analysis is the question of the participation of rural people in fostering their capacity to cope with the threat of a run-down ecosystem. Zungu had a view that:

> People will begin to express their concerns more with greater understanding of what is going on in the environment. They do to a certain extent. There are a few people who show they care - they send some of their letters to the news paper showing concern for environmental issues. It is relatively small, because largely people have no surplus effort beyond their concern for survival. I think that, that should change and in Kenya for example, which is relatively richer than Uganda - though a poor country - there is a

> lot of environmental activity. Some of it is driven by expatriates but most of it is indigenous.

From Zungu's previous statement, the interaction between scientists and rural people and the environment has tended to focus on seeking information from rural communities on the state of environment and their interactions with the ecosystems. Zungu identifies a vital aspect of science research and activities with participation with communities, rural and urban, is ensuring that people are given information which empowers them to develop a new way of thinking and comprehending the complexities of environmental crisis and development activities. He cited the example of Kenya in relation to many community-based organizations addressing environmental problems in their localities. An example is that of a well known woman environmental activist Wangari Maathai who organized women into a Greenbelt Movement of tree planting to stop soil erosion. Gore (1992), in his personal interaction with the Greenbelt Movement in Kenya, points out how the availability of information woman to woman is extended beyond aforestation to discussions on family planning and distribution of birth-control technologies. He also found out that the Movement's tree nurseries serve as a genetic storehouses of indigenous food plants carefully matched to the micro-environments of different altitudes and soil types in the country. These forms of discourse reaffirm the interconnections with communities, hence with the Earth, that could give science and science education the edge it needs to strengthen its social responsibility dimension in defending and protecting the people's rights -- like the right to breath clean air and drink clean water -- and ecological balance. What these interactive processes between science and the community imply is not a surrender of reason or what some conservative scientists might consider a leap into mysticism. Rather, as Lovelock (1979; 1991) explains with insight, we can still acknowledge the importance of empirical evidence and applications of carefully selected and appropriate technologies in informing belief and making a living, and still take nature's inherent right to care and respect.

In adhering to the conservatism of using the scientific rationale of objectivity, some scientists and science educators succumb to looking at hunger, famine, poverty, the high infant morbidity and mortality rates as a result of bad land use and over-population like Harrison (1992) does. Harrison argues that the misuse of land is due to over-cropping mainly for export at the expense of food production. This view fails to underscore the injustices to Ugandans from other structural domains. On cash cropping for example, this stance overlooks the exploitative pricing system for cash crops both locally, by the corporate or nation-run cooperatives, as well as by the international market system. But as scholars like Caldicott (1990; 1995), Suzuki, (1989; 1994), Lovelock, (1991) and Capra

(1982) who are proponents of science and technology for nature and people have critiqued, a strictly objectivist view also overlooks the impact of the increased use of fertilizers, pesticides, acaricides, irrigation extensions and land degradation due to the misuse and destruction of tree cover often marshaled by the state or transnational projects. While, for purposes of analysis, science discourse can distinguish facts and values, a holistic view of the life-world fostered by closer interactions with wider communities and their issues allows greater understanding to guide choices of value, and values guiding understandings.

6.2.1 The Global Forces

Colonial rule entered Africa in the mid- to late 1800s and found traditional or indigenous lifestyles with a strong cultural foundation. When African states like Uganda gained "independence" in the early 1960s, colonial rule left behind two sectors, the "modern" and "traditional" Brown (1995). The two contradictory ideologies left behind in the wake of independence is described by Shivji as follows:

> ...the traditional sector epitomized poverty and backwardness. Its ideology was parochial tribalism while its members related to each other in terms of kinship and governed by status. The opposite was the so-called modern sector. Dominated by values of individualism, bound together by contract and producing for the market, it was forward and outward looking , and therefore the image of the future, of economic progress and national polity (Quoted in Brown, 1995: p. 38)

The conviction among the ruling class in South nations, which is partly a result of the colonial socialization and the conditioning of the market forces and aid agencies, has led to the adoption and pursuit by the South nations like Uganda of what Shivji describes as *forward and outward looking* view of economic progress. This trend has, in recent years, attained an "aura" now called globalization, which has largely taken the form of an increased role of market forces and private capital among and within countries (Stewart, 1995). The dominance of market forces, Stewart argues, are built upon a well-founded agenda in which the indigenous feudal and paternalistic support mechanisms provided by the extended family and community is disassembled in order to give way to the market forces which involved goods, technology, labor, capital, and ideas.

This extension of the reliance of originally self-sufficient indigenous communities on the provision from regional and national economies has increased with the advent of centralized organization of the South societies by the state and forces of modernization. This new dimension, fired by industrialization, has meant that the provisions for local communities come from the world market, renowned for its being a source of luxury items and advanced technology (Brown, 1995).

As earlier pointed out by Osukuru elders, modes of production in their pre-modern society had relied on handicraft technologies, with agriculture at the center of production activities which, as the elders explained, were based on reciprocity, and primarily used human and animal sources of energy. The modern way that shattered this age-old pattern seems dedicated to continuous change, as new knowledge about how natural forces act is applied systematically to technological innovation which in turn leads to further discoveries and applications. The unrelenting valor by which the rich industrialized nations pursue scientific and technological innovation is, to Neddi, one of the participants, extremely deleterious to the bonding between human activities and balance of natural systems. To Neddi, development under the model of competitive markets, industrialization with its ever advancing science and technology...

> ...has possibly done the most destruction to the local and global environments. In the 1960s, there was that competition among the super powers: the USA and the former USSR the climax of which was in 1969, I think. This competition was about going to the moon. They went and reached there, and I understand they no longer go after Apollo 14 mission. But what did they gain? Much gaseous emissions were spewed into the atmosphere destroying the ozone layer in the process. Today there are still launches of space craft. How much matter is released up there as these spaceships break through the atmospheric barrier and the outer space? What are they going to look for there? For who? Consider the amount of money involved, and how much that could have achieved in addressing the environmental and poverty problems already created.

In the name of scientific and technological discovery such as space exploration, Neddi claims that the rich nations are knowingly engaging in activities that are responsible for serious environmental destruction. He seriously questions the adventurism into space and the deeply held assumptions of the technological society which ignore the deep understanding and considerations of the links of the advancements, and innovations of science and technology on social and environmental problems prevalent today. Neddi's perspective of scientific and technological advancement has support from the "Green Movement" which criticizes the unchecked industrial growth that has characterized much of the world since the nineteenth century as bringing the earth to the brink of ecological collapse (Worster, 1985).

The notion that scientific and technological innovation can qualitatively change social relations and conditions for the better hallmark of modern thought is challenged here by Neddi who compared this continued conquest of nature to a male dominated family life:

> It is like the father in a home. Participating in his own selfish activities which affect the whole family. Looking at the whole world as a family where the husband is, say, the USA; what the USA is doing at the global level is very important. But because of this struggle for power among the super powers, they are wasting a lot of resources which would be used for controlling this environmental degradation. Imagine how much money the USA uses in one day for maintaining all their war machinery, their spies, their submarines, their warships communication systems and so on. That money would go a long way in solving our environmental problems, but just because of greed for power, the whole world is suffering. At the same time they are generating and disposing of a lot of dangerous things in the air, land and water systems. They have also made a lot of bombs, which is in stock to do more harm to the people and the environment; we should rest assured that they will use these weapons of mass destruction at the slightest threat to their power position in this world.

In Neddi's picturesque analogy above, while globalization, with its inherent power struggle for domination, has created enrichment opportunities for some nations and groups, it has also harshly affected or completely left out many others. In other words, rather than creating the assumed safety nets, globalization and its markets, science and technology now threaten to destroy those who are marginalized. Mamai, one of the high school science teachers participating in the this study's workshop, expressed similar views, stressing possible alternative uses of the huge budgets of programs like space travel and militarization in support of the poor nations' struggles:

> I would think that in Uganda, for example, this money would come in handy in availing people environmentally friendly housing, as well accord us possibilities of using renewable energy resources instead of having to depend on the forest cover for both of these vital needs. This money could have been of better service to humanity than servicing selfishness and greed of the few who seek power and control over the majority. If this alternative approach to use of wealth was adopted and pursued, we and the environment would survive better.
>
> I also see that if this money was used for educating people towards a participatory approach to education in, on and for the environment, on population, on peace and security. We would have a better chance for quality life in a quality environment. In agriculture for example, right now we graze our animals on the grass we also need for roofing our houses; and these roofs last just a season and require constant renewal. Imagine the combined effect of these equally heavy demands on the soil cover, its fertility and vulnerability to erosion.
>
> If people were given options of better animal rearing techniques, and better housing for families in a manner that vouchsafed the quality of the soil like collection of animal manure and its use to recharge the soil nutrients, recovery of biomass energy through biogas plants, could be more environmentally and socially sustainable.

The growing catalogue of recent calamities attributable to the malfunctioning of science-based technologies, like the Chernobyl, Bophal, the Challenger explosion, and the Exxon oil spill and the industrial release of poisons that alter the climate, disrupt food chains, destroy forests and spread radiation and toxic compounds throughout the biosphere, (Dahlberg, 1985; Nelkin, 1992) provide convincing arguments which backup the concerns expressed in Neddi's and Mamai's narratives. These participants also note that new technologies feed relentless militarism exacerbating the threat of nuclear, chemical, and biological warfare. Since industrial economies create these maladies amidst illusions of affluence for a privileged few while robbing people around the world of the most basic means of survival, the view we share from Mamai and Neddi is that hazards of further industrial development now probably outweigh any possible human and ecological benefits. Their call is for reciprocity among nations of the world towards ameliorating ecological and social ills that have emerged and continue to rise.

Similar critique on globalization has been sounded by analysts like Susan George (1987; 1994) who has lucidly discussed how, for example, the capitalist development model framed by the rich nations and institutions like the World Bank and IMF have operated to this day to widen the gap between the rich and the poor, both among people and nations. According to George it is "the mal-development model that helped get [the poor] nations into debt in the first place" (1987; p. 244). With an increasing external debt among the sub-Saharan African nations which in 1990 was nearly the whole of their combined incomes (Brown, 1995), the impact of debt repayment and restructuring policies like structural adjustment programs further aggravate poverty by putting pressure on governments and already impoverished societies in the South nations to overexploit and destroy the environment. The experience of newly industrialized nations (NICs) like Taiwan, South Korea and others moving to this level of high industrial status show the strength of the tide to industrialize irrespective of environmental costs. According to Goerge and Sabelli (1994), China, for example, wants a multi-million dollar loan for the development of coal-fired power plants, oil and gas development and for domestic and transport system applications, this in spite of the high carbon dioxide emission levels which would exacerbate the greenhouse gas accumulation contributing to global warming. The Yangtze Dam project, also in China, is instructive about how the drive towards the North industrial status will not let environmental care deter the agenda. According to the Edmonton Journal (1995), the construction of the three gorges dam along China's Yangtze river will create a reservoir 600 km long, flood 12 major cities, displace 1.2 million people, flood one of the world's great natural sites, destroy habitats rare species, and obliterate cultural landmarks.

The Baconian mission to reorder humans' relation to nature through industrial technologies in order to escape the traditional human fate of being helpless victims of untamed natural forces criticized by Merchant (1980; Leiss, 1978; 1972), seems to be gaining momentum towards an uncertain but potentially dangerous future. With the obviously hard-line pursuits of the rich nations of the world focused on economic and political control using market forces backed by superiority in scientific and technological advances, the struggles to abate ecological disasters seem to ride on an invincible political ideology rather than practical considerations based on moral ethics cognizant of coexistence with nature. One of the university students participants, Twaha, had this view of the whole "development" agenda:

> Why should rich nations talk about energy and pollution all in passing when these are big issues? The North is polluting the environment more than any other parts of the world. Ironically, developing countries have a chance to keep the environment least polluted if they respond in time.
>
> In practical terms, it is good for us developing countries to keep our environment clean of pollution, because this may be one of the ways we may preserve ourselves. That is why I would think no rich nation thinks of passing technological development to the poor countries. They want to see us dependent in some way. We are more of consumers of their technology; they keep polluting their environment but at the bigger level we are the best purifiers.

He gave an example of what he was talking about:

> In 1992 there was a conference in Brazil where people were very bitter talking about the rain forests, like Amazon, which is feared will disappear very fast to a point where it is raising international concern. This not withstanding, people are dying of hunger and poverty even in Brazil itself, yet no one raised these issues. I feel this is a very one-sided approach to problems. Issues of developing countries will continue to be sidelined as long as we ourselves do not take cognizance and responsibility for them. To me this whole thing looks more of ideological than realistic so the we in the poor disappear and they take charge of the entire globe. After all they have the technology to do it. Look at how they are manufacturing the dangerous weapons, the nuclear warheads which can wipe out large portions of the earth with one detonation, and they are perfecting them everyday, for whose benefit?

This discussion took place in October 1995 at a time when Germany had just made an announcement, reported in the British Broadcasting Corporation (BBC), supporting the French nuclear testing in the South Pacific Islands in spite of all the demonstrations against this by the Islanders, Green Peace and other concerned world communities. The news reported the German support of the French nuclear testing was based on a claim by the

French that the tests were scientifically proven not to be harmful to human beings; thus justifying their continued testing. One is left to wonder whether the Islanders were party to the scientific proof. Why was a negotiated agreement to the Islanders' hosting of the testing not made in the first place? Of course it did not occur to the French parties involved that given its safety, the tests could be conducted at home.

6.2.2 Foreign Aid and Development in Uganda

The colonial past of African emergent states has had its impact on the economic, environmental and sociocultural frameworks probably more than anywhere else in the world (Harrison, 1987). Despite the fact that these impacts are wide ranging and capture practically every aspect of human conditions in Africa, perhaps the key ingredient that still threads the national policy formulation is belief and commitment to economic development and technological control over ecological systems. Among the proponents of this view is Kahn (1980) who vigorously argues against those who would limit economic growth, saying that only unbridled growth would bring social progress. Kahn's scenario for the period 1980 - 2000 is one where there is growth of world markets for food, the ability to introduce advanced science and technology effectively into lower-income countries in the South like Uganda, and the availability of cheap labor. This level of advocacy legitimizes the strong belief in economic growth through industrialization based on modern science and technology. What this has meant for African states now independent but interdependently linked to former colonial powers and allies is the transfer of specific forms of technology, and especially the pursuit for scientific advances through education.

The university's leadership role in education is itself dictated by ties of dependence on overseas donors, which has ushered in another dimension of issues that further constrain the sense of autonomy. Nadda, a lecturer in animal physiology and a graduate student of the Faculty of Science, shared her feelings about external aid on national issues of environment and development. With her university experience at Makerere, the expatriates and foreign donors...

> ...come here and constrain us saying: *we are giving you so much money for conserving forest A or forest B.* But the local woman who lives around that forest needs to stay alive. The thing is, it is not that if you are given two options, a human life or an animal life or wild life: which one is more important? We are advocating for mutualism. All these things are necessary. The human life depends on these other resources we have, and there must be sustainable utilization of these. But if we have alternatives to turn to. Like I give you an example of my area in the north. It shines half of the year. Really burning hot. People come here and talk of solar energy systems. They come and show demonstrations, then they disappear. They

> do not want to transfer the technology here so that we can store that solar energy to last as long as we'd require. Now are we solving this problem as a university? We are not. Such should form a research agenda in science and technology here in Uganda.

Nadda's reflections here focus on the lack of funding and appropriate technology to address the local needs of the majorities in Uganda. With a cluster of problems faced by a poor country like Uganda population increase, poverty, militarization, waste and environmental degradation, climate change, and food and energy shortages the intensity of these are overwhelming for government and the people. Response by friendly nations in the West with generous donations or loans as a relief effort in times of dire need are a welcome gesture. Nadda's concerns here relate to contextualization and sustainability in such aid and/or loan schemes in education and development.

On contextualization, Nadda's argument seems to point to the need for donors to 'humanize' their aid programs. Her example of donor support for forest conservation indicates how, as a Conservation Science, forest conservation practices promoted by foreign donors excludes the indigenous traditional peoples' interactions with the forests in question. She thus sees such conservation efforts as missing out on the vital aspect of reciprocity between traditional people in the catchment areas and the natural resources. Nadda ties contextualization or people-centered programming of development initiatives with sustainability. For a donor to fund a conservation program of one forest is a contribution, but she would rather the effort evolve implementation strategies that could curtail future resource depletion of the same kind. Her experiences in working relationships at the University seems to have exposed her to passive attitudes of some Makerere University scientists towards sustainability concerns. Nadda also challenges initiatives at the University's Faculty of Science , accusing it of failing to sow the seeds of ecologically coached research and development. Such a shift, according to Nadda, could facilitate a scientific praxis and corresponding technological spin-offs from such ecologically informed scientific inquiries to changing and ameliorating the conditions that make people and the environment mutually vulnerable to each other.

The problems and prospects in the acquisition of technology from the industrialized nations by a developing country are latent issues behind Nadda's remarks. Among these are the whole education system and structure, existing production methods, the mechanism of technology acquisition, the availability of local resources, their utilization and adaptability, and the possibility of diffusion of local technological capability. Her outcry against the apparent lack of empathy among foreign donors who have the money, the knowledge and/or technology but "deny" Ugandans its applications where they need it is really a cry for help. There is a local African saying that *a person who calls out for help while among a group also informs of the helplessness among the group members.* In the educational perspective of Nadda's narrative, the issue challenges the educational philosophy and the structure of the curriculum, especially at tertiary level, on its research and development agenda. As earlier mentioned, Uganda's colonial history has shaped its current education (Kwitonda, 1995); where the primary aim of the colonial education systems was to create an administrative cadre and a limited number of technical professionals like lawyers, engineers and teachers.

The philosophy, attitudes and approaches to such educational curriculum and structures are responsible for keeping developing nations like Uganda from evolving endogenous priorities of education. Accordingly, an average scientist educated through the curriculum fails to appreciate that the application of the science gained would require both an understanding of the science as well as an understanding of the system to which it should be applied. Rather, as Carnoy (1980) has discussed, science students get to a local institution, or in some cases, are sent for specialized training in industrialized nations but qualify to run and extend the transnational science, technology and culture rather than to the local needs, hence contributing to the helplessness in always looking at donors for support. With science and technology increasingly becoming the primary means by which humans interact with each other and with the earth, their use should involve determining and experiencing ways that are socially and ecologically centered. For historical reasons earlier mentioned, Uganda as a country has tended to rely on technology transfer from the industrialized nations, it was Nadda's view that:

> The technology should be brought here, and then we find alternatives. Even someone who is illiterate will see the advantages of maintaining these natural resources as long as alternatives exist. And I think that could build up from an institution like Makerere to take that challenge of modifying foreign technology for our purposes. If there were facilities in our faculty of technology and in Physics then, you build up these things, demonstrate and get them to work in ways meaningful to our people's way of life.

According to some scholars like Franklin (1992), Leiss (1978) and Leiss (1972), technology has a number of important characteristics, the consideration of which have significant implications on its impact. These include, first, that technology is an outcome of ingenuity guided by human beliefs and purposes, making visible the deep beliefs that consciously and subconsciously motivate society in its use. Second, through technology the people-planet relationship is made explicit. To have technology transferred to Uganda and get Ugandans to explore its alternatives, as previously proposed by Nadda, is an acknowledgment of the failure of Uganda to create an environment under which new and appropriate technologies could be developed locally. Besides, her recommendation that foreign technology be modified to suit local conditions extends to catering for the cultural dimension in its struggle against the foreign values. Nadda's sensitivity for technologies which are environment- and people-friendly is reflected in her call for Ugandan scientists to come up with alternative technologies that could reverse total traditional dependence on natural resources like wood for fuel. It is an acknowledgment of the importance of a critical appraisal of science and technology, of their effects on people and ecosystems, and of the extent to which their various forms are to be made appropriate.

Within the prevailing framework of donor support to Uganda, in science research and education, the approach has tended to be one whereby the Ugandan institutions, individuals or groups are used as channels to promote exogenous innovations and or interests.

This was acknowledged by Mukasa, a female science educator who observed that:

> If someone writes a research proposal on mountain gorillas and passed that proposal to any conservation organization, and another person writes a proposal on pollution on any lakes here, you can be sure that the gorilla proposal will be given priority. As recipients, we have no or little voice. Even those who are coming to develop us: what is now called capacity building, they come and spell out what they consider important to Ugandan higher education. Makerere cannot have a say on issues we want to address; often it is on the take or leave it option for most of these donors. So we have to succumb to being docile recipients.

Her example has particular reference to some donors[22] like the WWF that favor specific aspects of research in the environment. When this element is strongly embedded in donor support for science technology education and research, for example, on what the funding should be for, and on which facilities the university needs, the effect is to undermine and tilt internal prioritization. The common tendency of donors to determine what the money or facilities they provide should be used for undermines and tilts internal prioritization. There are numerous examples of environmental aspects which are needing urgent attention in Uganda, as she noted:

> There are so many areas that the university needs to address, especially in the area of pollution before it gets out of hand. In Kilembe, at the cobalt mines, it is sad news. I know that a bit of research has been carried out; but I do not think there has been any monitoring system. Those cobalt piles have stayed there for so many years; even in Jinja where they used to smelt the copper ore; and those piles are very close to the Lake, and have been there for decades. Consider the villages around these dumps, where these people have their *shambas* (gardens), these are clear hot spots which need to

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[22] *The attempt here is not to blanket all donor support to university science-technology programs, as insensitive to local needs and/or participation. As will be shared later, the Norwegian National Committee for Development Research Program (NUFU) for Makerere favors local identification of priorities.*

> be studied and addressed and taken care of because it has long term effects. There are many similar pending issues which are very crucial and await to be addressed by local scientists, and educators in this country.

Twaha, one of the graduate student participants in the study, shared his experience and insights on how foreign donors show total disregard for the actual conditions on the ground:

> For many environmental conservation programs which have been extended to rural people, like the one that was brought to my village, our people did not understand its rationale. My village example was a tree planting program organized by the Anglican Diocese in our district and funded by a certain Germany organization. When they came to the designated area for aforestation, they found it was a mountainous region with a lot of trees. People there hardly have land to due to expanse of the forests there. This organization wanted people to plant trees in their already limited gardens. People were shocked because there are many trees in the large forests to a point where people are even short of land for cropping. So we resisted, and instead suggested alternative ways we could be helped, like supporting our farming efforts through local development of implements that fit the terrain. The white man was so angry and could not even listen to the people. He dropped the program and vanished.

The idea communicated by these citations from the participants relates to how some (external) donor philosophy comes to reinforce the century-old adage that local traditional systems in Africa knowledge and technologies are 'primitive' and inappropriate to boost productivity as the West and the local elite groups, including some scientists and technologists, would like to see it. With this view, science and technology wholly copied from the industrialized nations is being strongly advocated and implemented in educational institutions with a view to modernizing the production sector. In the agricultural sector, for example, this assumption has proved misleading in guiding small-farm development in Uganda (Olupot, 1995). This is because scientifically and technologically alien approaches bypass the peasantry, compounding a legacy that links rural poverty and environmental degradation.

The idea expressed by these participants is that science and technology and their corresponding development in education should operate on the basis of a 'bottom-up' approach, starting with existing human and physical resources: local people, their needs and aspirations, their knowledge and technology, and their natural resource bases.

As Altieri and Yurjevic (1995) succinctly argue, while advocacy for indigenous perspectives have penetrated academic and political circles in developing nations and internationally, it has remained strictly an academic matter, or political rhetoric and hardly ever emerged in public discourse in a practical sense.

In my interview with elder Dikko of Osukuru about how science could help them, this is what she said:

> *Emutono akwap, mam inwakakini itungan akim akonye.*
> *Iware, inwakio akim orot.*
> When leading someone in the darkness, it is debilitating to shine the light directly into her eyes. Rather, in the darkness, you shine light on the path.

This response should speak volumes to scientists, educators, and sincere friends of people of the South who seek to support their struggles, alongside applications of science and technology for our (South) appropriate development.

I had an opportunity to meet and talk to the Norwegian Coordinator for the Norwegian National Committee for Development Research (NUFU) Program, Professor Endre Lillethun, during his official visit to Makerere in September 1995. In his explanation about the role of the NUFU support to Makerere University[23] was that:

> The Norwegian philosophy of extending support to the developing nations is based on our interest and value in engendering self-reliance on a sustainable basis. Uganda has officially expressed need to develop science and technology for the development of its people. The support that NUFU provides to the science and science education departments in this university completely allows the departments to set their priorities. We do our best to facilitate these within available funding.

It is this level of openness from donors that would allow Makerere University to be highly selective in its choices and perspectives of science discourse and related technological innovations suitable to the Ugandan situation and leading to scientific and technological self-reliance. As Olupot (1995b) has observed, many areas need support in Uganda. But in many cases, when donors have responded, there has been suppression of the research agenda that could seek to address genuine problems faced by the poor majorities. He gives examples in Makerere University where the United States Agency for International Development (USAID) and the International Service for National Agricultural Research (ISNAR) which have played a leading role in shaping agricultural research in Uganda, provided the necessary funding including external expertise to facilitate local human resource development. This notwithstanding, he notes that the input into the research from the majorities to salvage agricultural development is lacking. This has preempted such donor institutions or organizations to hire experts from abroad to propose and implement action plans. In science and technology, such a scenario has meant that

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[23] *NUFU extends financial support to the programs in the Departments of Physics, Chemistry, Mathematics, and to the Physics, Biology and Chemistry units in the Department of Science and Technology Education (DOSATE); and slowly hoped to expand to other science departments and corresponding units at DOSATE.*

Ugandans continue to be dependent on North-based structures and inputs, and never toward expressed interests of the marginalized majorities. Unable to formulate internally motivated and meaningful science and technology agenda, a university like Makerere would seem to act like a conduit for perpetrating inequalities and ecological crisis in its promotion of worldviews, research agenda and knowledge validation that are categorically remote from the national contextual needs. Clearly this has implications on national policy in shaping and defining how people interact with the natural environment.

6.3 State, Policy and Environment

Belief in economic growth is widespread in many parts of the world. This "commercial" or capitalist economy, which characterizes the industrialized nations, relies heavily upon modern science and technology. Capitalist economies are based on increasing economic growth by a combination of a larger population and greater (average) per capita production and consumption (Brown, 1995; Redclift, 1984; Timberlake, 1991; Rostow, 1960). Such growth, as measured by "gross national product" (GNP), is generally assumed to: 1) raise the industrial and economic level of a country and assist its performance in global science and technology competition; 2) provide for full employment and control inflation; 3) increase the general standard of living and provide for a better quality of life for all citizens; 4) help eradicate poverty; and last, 5) provide funds for environmental protection and improvement (Griffin, 1989, p. 29). Events of the past decade have called into question some of these assumptions concerning the consequences of continued industrial expansion (Adams & Solomon, 1991). Among even the most industrialized nations, news is replete with increasing crises of inflation, unemployment, budget cutbacks and down-sizing of jobs. With these, the quality of life (in whatever form) may greatly deteriorate among the industrialized nations, but the corresponding impact to the poor nations in the South will even be greater due to already poor social services and lack of emergency response budgets. Pollution of all kinds is on the rise globally. The increase in lifespans and the spread of preventive medicine notwithstanding, there also seems to be a crisis in health care systems. As Nelkin & Brown (1984) have analyzed, the very nature of health and disease has changed in the last century due to civilization.

Most of these are a result of environmental pollution and/or impacts due to changes in technology. They include cancer, heart disease, mental illness, arthritis, cirrhosis, respiratory diseases, and various forms of accidents involving evolution of science and technology. The large and rapidly growing volume of scientific and technological knowledge in health and medicine present problems of assimilation, integration, access, education, and in the South contexts, delegitimization of indigenous medical knowledge and practice. A holistic movement notable in the North nations both within and outside the medical profession is symptomatic of some of these changes in emphasis, technique, and policy (Iannone, 1987). In the South nations, the potential to respond to these changes in health and other scientific and technological changes could be greatly curtailed due to high indebtedness to the World Bank, the IMF, and to the industrialized nations, and lately, Structural Adjustment Programs (Brown, 1995). And as Griffin (1989) notes, the costly transfer of science and technology to the developing nations has its problems which have been ignored, among these the interactions between science, technology, environment and the sociocultural groups. The increasing awareness about the incompatibility between economic and environmental concerns bring to the center stage a need to debate the goals of development.

In many parts of Africa, including Uganda, the World Bank and other related agencies now spearhead responsibility in providing research funding, training, and implementation of various development as well as natural resource-use related programs. What this State-Development Agencies' relationship was like in Uganda vis à vis policy was voiced by Karali, one senior officer in the Ministry Natural Resources:

> When we look at what is going on in this country in the area of environment, much of the activity that you see people engaged in is funded externally; in environment in particular we depend on donations by WWF, IUCN, DANIDA, NORAD, UNDP, USAID, World Bank Programs and others. I know that some of these donors like World Bank actually support policies which penalize the environment and poor people, but they are the same institutions trying to cure the environmental problems that affect us. This is because our governments are themselves being dictated by these same institutions, through loans and other programs. This is the problem. The very institutions that push for policies like industrialization, intensive agriculture using chemicals like fertilizer which they sometimes condition on some agreements, are also giving us the funds and the strategies for correcting the environmental problems on their term. So the whole thing seems to recycle itself into itself. I think that is one of the main constraints we face towards proper policy making on environment.

Karali's input brings to mind the strong implication that Ugandans are not in the forefront in the decision-making process regarding their personal, social and economic welfare. They have tended to fall victim to supporters and experts, in concert with local elite who themselves tend to embrace modernization, to map out the local problem as well as the solution strategies. He pointed out that the Ministry of Natural Resources is among the new government ministries and is in the process of organizing for cogent policy formulation. The National Environmental Management Authority (NEMA), as a key player on policy formulation and implementation, was in the process of being formulated, to be charged with the task of advising the Government and Ugandans on local and international environmental concerns that affect Uganda.

Similar tension seems to accrue to the plight of the poor and marginalized rural majorities in relation to the poor articulation of policies and issues ranging from technology, development, natural resource ownership and or management, and actual environmental care. These are increasingly compounded by limited access by the rural and peri-urban masses to land, credit and reasonable market prices for their products. In many cases, the majorities have even been accused of resistance to change. One such a farmer had this to say:

> I have been thinking about this "resistance-to-change" accusation. And I say it now clearly: it is the landlords and the government who are resistant to change! I mean have they not done everything to fight our demand for a change in the ownership of the land? (Mang Pedring, peasant farmer, Philippines; quoted by Burkey, 1993: p. 8)

Such views relating to presumed "lack of modern outlook" among the poor vary from derogatory to the genuinely serious, often based on the broad concept of resistance to change. Governments, bureaucratic donors and international institutions like the World Bank say poor people resist change because they are ignorant, superstitious, fatalistic, even lazy. These labels against the majorities distracts some of the contradictions of development policy, with ecological damage and quality of life of the people. From elder Katan of Osukuru:

> We continue to survive in all these hardships because we work very hard with what we still have left. With just a little help, we can live happier lives with clean water, better health, nutrition and ways of production that we can sustain. We suffer a lot here with strange diseases, poverty and a dead land with low food production. We don't know whom to turn to.

The ability to overcome some of the environmental problems caused by peasants is dependent upon the attention given to the structural causes of poverty. As we earlier heard from the Osukuru elders and other participants, population pressures and poverty intensify deforestation caused by overgrazing, or the need for more arable land and firewood. These lead to desertification, soil erosion, flooding and micro-climatic changes. Malnutrition, disease, lack of clean water and proper sanitation weaken the poor, making it difficult for them to break the vicious circle of poverty. High rates of childbirth weaken women physically, so only easily accessible resources are used, leading to their depletion. Such problems can be overcome with political will from government through people-centered policies. But as Freire (1972) informs, welfare programs funded in the South nations by the rich nations in the North and or by Transnational Corporations (TNCs) can be instruments of manipulation which ultimately serve the purpose of dependence and domination. He considers them as an anesthetic, which distract the oppressed from the true causes of their problems and hence from their concrete solutions. Such ties between local elite leadership and international institutions stifle the representativeness and the responsiveness of policies to majority needs and those of the environment. As Nietschmann (1987) has discussed, governments of the developing nations are, in this view, saddled with overgrown bureaucracies attempting to control all aspects of rural people's development, including their relationships with the ecological systems around them.

Policy structures that promote and support these normative participation and interventions of international agencies suppress the formulation of an internal agenda that could innovatively address the genuine problems in the natural environment faced by people, as pointed out by the Osukuru elders earlier.

Poorly articulated policies, coupled with hierarchical administrative mechanisms in African states prohibits the realization of growth or development as a process of articulation and participation by the majorities, and of making the end product of development "the persons themselves, knowing what they want and acting to get it" (Nyoni, in FAO: 1985, p. 14). So while aid to national development strategies in poor nations in Africa has supported some important and essential programs like healthcare albeit for the benefit of a privileged few, the above narratives from study participants demonstrate that the partnerships between government and the poor majorities in rural areas on matters of policy formulation and implementation appear to have missed the vital ingredient of conscientization which could have served the purpose of 1) increasing government's and implementors' understanding of the local situation; and 2) increasing the insight of the local people, especially the poor into what factors and relationships are the root causes of and contributing factors to poverty, disease, and ecological crisis. This, according to Cawagas (1996), is a dialogical process which allows horizontal, democratic and participatory exchange of knowledge and experiences between the masses and the government. Interpreted from this perspective, the participatory formulation and/or implementation of policies related to science, technology, environmental care, and education undergo critical analysis through open discussions which challenge the contradictions and authenticity of such views.

An aspect of the tension between environmental conservation policy and local people's participation in Uganda was highlighted by Zungu, himself an expatriate at the National Environmental Action Plan (NEAP) in Uganda:

> The interactions between people and the environment and also a whole range of sociological issues are key. For example, what one comes up very frequently is where one has got a national park or a forest reserve and traditionally people have not been allowed access to these resources. Now the modern view is people should have some benefits from the resources provided that this can be done sustainably. But implementing such a policy is very complex because how can you work out how much firewood or how many medicinal plants or how many antelopes people can take sustainably. It is not easy and even if you knew the answer, it's quite difficult to implement such things. You are not going to stand and watch how many leaves of medicine a man collects from a plant. But if there isn't some feedback you may find in ten years' time the plant has become extinct. Which would have been not sustainable.

Being an expatriate, the question of participation by the local people did not make much sense to Zungu, for he pointed out that the people he works with are Ugandans. Zungu was also confident that by working with local Ugandan elites in policy formulation and implementation strategies identification, overall national interests were being considered. This flagged a grave shortcoming faced in developing nations in dealing with foreign expatriates whose view on policy formulation and implementation is deeply embedded in the modernization and technocratic paradigm of development, which considers their role as "experts" as that of directing the local elite. The participation of the latter is automatically assumed as both an encounter and answer to the felt needs of the local majorities. In Zungu's educated view,

> there are many good policies here in Uganda but the implementation and internalization is poor. I think one of the major things that is needed is very great deal of education. Because the real problem of environmental degradation is increasing population coupled with people's rising expectations. So the demand of all these people's living causes a massive demand on the resources.

But even education has its large share of opaque window screens all-round. Lamenting on the relevance of such frameworks and perspectives, Mamai, a high school science teacher, had these concerns when he remarked:

> When have looked at education, is there a way the policy makers can also come in here to assist us in educating towards alleviation of environment problems in this country? Much as there is the Ministry of Natural Resources in this country, I do not see much difference it is making. I liken it with the Ministry of Agriculture where you have the agricultural extension workers but they are doing nothing to teach sustainable agriculture. It is fashionable to hold seminars, but the way I see seminars going on as some NGO experience has shown, people go there for the sake of getting some

> cash. But the practical element of improving on what they have gone there for is not there.

Zungu shifts from his strong recommendation made earlier that, to develop, Uganda must industrialize, modernize, and have rural people shift to cities to operate under capitalist market forces. In this assertion, Zungu had denied the importance of place and environment in favor of global vandalism masquerading as progress, believing that environmental and social improvement requires further expansion of the very activities that wreck ecological systems. Put in the context of sustainable futures for people in their ecological settings, these latter remarks by Zungu and Mamai relate to the need for Ugandans to change their attitudes, energies, and understanding and look at things from a new perspective. At some level of cognition there is an awareness of the dangers in ignoring the political, social, and economic pressures that impinge on the ecological balance and the creativity of place and nature-centered people in rural areas. The initiative and commitment of organizations and national agencies purporting to ameliorate environmental and social woes are scrutinized.

Among scholars who have analyzed African education and its foreign support effort, there is a strong view that the agenda being promoted functions to disseminate a particular understanding of development. On his reflections on this issue, Samoff (1996), for example, convincingly points out that such agenda have undermined the optimistic vision of education and its role as articulated in various African forums over the last three decades of post-colonialism. With growing poverty, starvation, rising food imports, deforestation and desertification, the African condition is very bleak. Agencies like the World Bank (1994) attribute the crisis to deficiencies within Africa itself, blaming our poor policies as a primary cause. In this foreign perspective the solution is seen as development assistance from World Bank, IMF, and other agencies. On this issue, Toh (1996), a peace educator and development scholar, cautions about prevailing conceptions of these North-South partnerships which he lucidly argues is not necessarily addressing the "unexamined taken-for-granted assumption about the desirability and transferability of North knowledge that is, technological frameworks, skills and strategies within the dominant modernization paradigm of development" (p. 184). The persistence of poverty in Uganda amidst continuing environmental degradation and the belief that modernization will be the savior may call for a comprehensive alternative understanding of the African condition in general, to explore the interconnections and firm sense of context among aid, education, science, technology, environment and development.

Traditional communities in Africa have historically survived what is considered the harsh environment through high levels of cooperation and have emerged into the modern milieu with a tradition of working together. The colonial and post-colonial era ushered in a competitive instinct promoted by modern industry and the market system (Brown, 1995). To optimize the shift from traditional to 'formal' sector which demanded minimum cooperation but maximum competition, nations in Africa have had to centrally evolve policies in all sectors including education, agriculture, trade, and industry. This is to the effect that the African peoples lost the right to identify their own problems and map-out their futures. Given this history, the formulation of policies and strategies that could foster indigenization of scientific and technological discourse would be seen as antithetical to 'development'. During the workshop, Loma Bon, a university academic, shared his experience of the exclusive ways in which serious educational matters in Uganda are run, pointing out that:

> We ended a workshop on *Education for All* yesterday at the International Conference center, Kampala. Not a single ordinary teacher was invited to participate. It was just people from the top, but even those were carefully selected. To get in there I had to write a letter which pleaded my right as an educator to participate in forums that concern me. Initially I was told the places were full. You find that this segregation of the majority of educators extends to educational policy formulation.

Complementing Loma Bon's remarks, Mzee provided an example in education, saying:

> These are very vital issues you are pointing out here. There is that part of this discussion: the relationship between the implementors and the end-users of a policy on the one hand, and the policy makers (government) on the other. There is the example of the Ministry of Education policy on extra tuition (coaching) in schools. Many children from poorly staffed and facilitated schooled benefit from extra tuition. But policy now has put an end to this. My question is, in which kind of schools are the children of the policy-makers? Certainly in the best facilitated and better staffed schools. Who knows, some of their own children might even have personal tutors right there at school. To the majorities, there is a *No Coaching*. policy! Do these officials think we do not notice these things? What people do is to circumvent the whole policy by underground coaching arrangements.

The centralized approach to policy was evident in the views of the participants. The view was that the circumvention of policies is also indicative of how campaigns against deforestation and drainage and or reclamation of wetlands in Uganda are widely undermined by rural people; these being the only resources they can fall to as a source of energy, arable land, food and income. Great complicity from the very enforcement officers like foresters were also noted. Thus the policies neither benefit the people nor the environment they are set out to protect.

An effective appropriation of policy was seen as diluted by lack of internalization due to the influence of selfish politicians as Neddi observed in the workshop:

> I think we have cited the greatest constraint. It is political influence. The politicians determine the policies, or they influence them even if they do not participate directly. Like our educational goals as spelt out in the Educational Commission Report of 1989. You find that it has a lot of statements like "education for integrated, self-sustaining, independent economy"; " revolutionary..." and so on. What do these mean to an educator?
> Having produced this policy review, since 1989, they have done nothing about it because they are still discussing the same issues up to yesterday as our colleague here who attended the *Education for All* Conference in Kampala has informed us. The same politician is the greatest problem with respect to funding agencies who come to help solve our environmental problems, they may come to help us plant trees, when they come, they register there with the politicians. Then they are assigned where to go.

Although in the Ugandan case there is a semblance of concern over the state of the natural environment and of equity with particular reference to the empowerment of women, the transformation of these political slogans to actual action-oriented programs is held back. The reason would appear to be that political influence stretches beyond influencing policy, to provision of funding and setting of priorities, including assigning of areas and sectors even for Non-Government Organizations (NGOs) that are now increasingly more effective in their support for the needs of the people in Uganda. The NGO involvement in Uganda has been increasing steadily in the last decade with their concern being guided by the progressive deterioration of natural resource base; the precarious subsistence levels of peasant families; the growing loss of identity among peasant groups; and the limiting factors that have inhibited peasant accumulation of wealth due to poverty. With these NGOs having autonomous funding sources, politicians have tended to influence geographical locations of their operation not so much due to need as to boost personal political clout in their constituency towards re-election. Lawino, an Adult Education Student of Makerere, has worked with several NGOs in many parts of the country. In part, she supported Neddi's observation of some politicians influencing location and even activities of NGOs in the country. But she also acknowledged how the present insecurity in some parts of the country, notably the Northern and Northwestern parts of Uganda, has kept the distribution of NGOs to the safer Central, South, and Western parts of the Country.

The lofty and much desired intentions of the NGOs were seen by the participants as being unfairly redirected and distributed by the (strong) politicians to take precautions for their own protection and elevation of status against national equity concerns. As the situation currently stands:

> Our politicians do not love the people down there in the rural or urban constituencies. They only love you when they want votes from you, often

> by giving you things that do no even last: they give alcohol, a little food in some parties, and then they do not come back. Like Okot p'BiTek says, *they are like weaver birds. They come dance around the garden, feed on its crop, when they are finished they disappear and come the next season.* Unless the politicians learn to love the very people they represent by sharing their problems, and to learn to stay by these people all along not only when there is voting to be cast, then they will be able to use the money from up there and the policies to the benefits of their people.

This callous attitude of political leaders towards the defense and rescue of the traditional peasant bases of production, culture and identity was, to workshop participants, a direct reflection of the nature of education as a medium that has socialized politicians and others occupying privileged positions to indifference to the plight of the majorities and of the ecosystem. Loma Bon illuminated how this lack of love, empathy, charity of feeling and association among politicians and other elites is related to the framing of education:

> That love is what we as educators have missed out by producing politicians without love. People who do not love their society were in school. To resolve all these issues we are talking about, I think the alien nature of the educationists is the key problem. The kind of attitudes, the kinds of aspirations set by teaching beliefs, the competitiveness rather than cooperation in the system. Eventually you carry justice of selfishness and actually disregard anybody else who is not like you. So if you are fighting for national issues, the national issues are those issues about your class, not about the rest of society so you do not care dumping toxic waste in the village out there as long as you get your money.

Participants identified a number of countries in the world that have made giant steps in pursuing internally coherent development through culturally endogenous form of science, technology and social organization. China, Japan, and Cuba were seen as having made great strides in development with a science which has been developed using their respective language and culture. But as we discussed earlier, these newly industrialized countries are really running a hard race to catch up with the industrialized North nations with total disregard to the effects of various development projects on the quality of the environment and lives of the people.

From these reminiscences, the workshop participants bring to our attention how modernization as a philosophy or worldview has objectively isolated educators, scientists, politicians and the policy makers from the interests of people and of caring for the sustainability of the environmental resources. Similar sentiments had earlier been expressed by the Osukuru elders during a combined focus group discussion:

> We were among the most self-sufficient peoples *(apol amio)* in this country. We had cattle, goats, sheep, chicken, and a variety of food crops. We fed and lived well. We no longer have those things among our people, because of the civil political and subsequent military scuffles in state power struggles this country has had. Our youth, and their being lured into these power pursuits have brought us these problems.
>
> Now we have nothing to live on. We have famine. Our children are malnourished. People, young and old, are in poor health. There is increasing death among our people. We have gone down in all ways, because we are no longer self-sufficient with what used to sustain us. Our self-sufficiency is now in poverty.

To these elders, there was no doubt about how the centralized form of governance, policy formulation and implementation is a key factor in the poor state of their whole life-fabric. They cited some examples:

> Governance (*aipuga*) is no longer in our control. In the old days, we made our own decisions. Our elders had ways of coordinating different clans, and ensuring balance. Our animals grazed freely. The animal diseases we had were controllable in our own ways. When government came here with the white man, they required that we periodically drive our animals to one common place for vaccination, dipping. This way some the animal diseases we never had before appeared. With your science *(akisisia)*, they brought drugs to spray in cotton, that chemical was not good. We lost animals. We lost crop output. All as a result of these innovations by governance. Even some medicines for vaccinating *(aikis)* people made many children lame. I think they brought expired drugs to give here.

To a role play question: "Suppose our current government came up to you and requested that you advise it as your custodian, in terms of what could be done to improve your situation, what would be your response?" The elders concurred with the workshop participants, saying;

> The election of the people who are in government is very important at this point. We believe that this current government is attempting to allow people to steer their own course in their localities. A government which advises, guides and supports people at their greatest time of need. As a people we ourselves should build up interest and practice some of our old ways.

Giving an example of the type of old practices they would like to see revived,

> Our traditional medicines were very good, and we still have most of the available, and known. Many modern medicines are not accessible nor beneficial for us. Our medicines are effective for many diseases. We also

> lack respect, collaboration among people, and caring for our land resources. We should value life. Our people never knew nor used guns and grenades that are now widespread in this country.
>
> There was no greed. We led a simple but rich life. We grew our food crops with oxen. We never fought and killed each other like we have witnessed these last years. Many people are innocent and deserve peace and good living in our traditional way. The hope now is in the way this current National Resistance Movement (NRM) government has allowed us to group and govern in the nine-home arrangement with Local Councils (LCs) could auger a good beginning.

To elders in rural communities who have had the opportunity of experiencing both the traditional past and the changes to a mass-consumption society that regards the natural environment instrumentally, the changes of life social and ecological are depressing. And as earlier mentioned, the land itself and all flora and fauna it nourished provided adequate sustenance which also included indigenous medicinal sources. The shift to modernization is pointed out here by the elders as having not only physically destroyed these potentials in the ecosystems, but also socially alienated people from the indigenous knowledge. They also derived a deep sense of satisfaction from caring for others and from being cared for. These latter remarks by elder La Patan inform of how the current government institutions have unsettled and down-trodden traditional ethics and societal dynamics. While reform is discussed by government, there are still many adjustments needed by the state machinery in terms of policy and implementation strategies. A formally highly placed policy official in a government Ministry who was recently retrenched from office revealed under a strong promise on my part to maintain his anonymity:

> We have a lot of human and natural resource-potential which is not tapped. Unfortunately, the debt burden is increasing for reforms which do not reach the majority of the people. A lot of reforms went to the elite. The rich people are getting richer while the poor people are becoming poorer. The village people need to be helped and redirected through education. We need to pump more money into extension work. Have more money in the education system, the formal sector. Spend more money on communication, information. If our condition was getting better, one would not complain too much about the way the big men and women are enriching themselves at our expense.

He refrained from giving examples but instead suggested what priority areas in national reform should be:

> We need to develop our own communities as models. We need to come down to the people. What is development for? It is for the elite in government, in Kampala? What is technology for? Government has instituted structural adjustment up here. We need structural adjustment down in the village. How far have these affected our communities? If at all we want to develop this country, what do we mean by this country? If you want to develop Ugandans, who is a Ugandan?

While these statements may not relate to a specific example, the ministry official did seem intent on providing a picture of how most aid funding tends to be used, signifying minimum impact of aid programs particularly to the ordinary people in urban and rural areas. Continuing his analysis of state-handled reforms and shortcomings, he said:

> We are swallowing ideas (uncritically) from anywhere. From where they come from we do not know. They look very good superficially. But they are causing almost four - billion dollar debt now from 1 billion dollars in a decade. That money could have caused a change in this country; a visible change which an average person would see. But the changes are still in Kampala. Industries are developing in Kampala. Vehicles are increasing no where to pack them - in Kampala. That is a change. The four billion dollars have done something. But where? They have improved the Sheraton, Nile Hotels and other places and a few individuals. It has improved there but down! It is even scary when one looks at these strategies and moves for decentralization. How is that going to help the already impoverished districts? I think that at this point I can describe it in a very bad way. But there is nothing good on earth. There is nothing new. They are only modifications of old things.

From his experience as a planner in the Ministry of Economic Planning and Development for thirty years, this participant expresses a strong view that the emerging industrial culture in Uganda is pushed by a development policy which will grossly affect the natural environment, in spite of government officials' public utterances about needs to care for the environment. To this participant, the way the state runs development issues was compared to the domination of women by men. Drawing his example from a polygamous marriage, he expressed a feeling that:

> When you have too many wives, and you cannot keep them, you can decentralize them. Say: *Every woman, take care of yourself.* A woman who does not want to educate her children, it is up to her. You the husband, you only come around, visit them; and then you bring some bread occasionally because you have to be received, you lubricate your relationship, your way through. But it is running away from responsibilities by the central government. Decentralization can be a very good principle, if the country had achieved a certain level of development and uniformity. It would be good if our development was uniform and was at a certain level. Because

> you have to collect local taxes. In many rural locations, I do not know what percentage of people pay tax. Even the people who are fit to pay tax, the amount of money they pay is very little and they are crying! And they are justified, for where do they get the money? What do they sell? People ask themselves: *we have paid tax for many years, since independence wouldn't we be able to see something that tax has done by now?* They are disgusted. But may be through this centralization that money might be able to do something through proper accountability and planning. So this decentralization is an experiment whose results we have to wait; only that it came too early maybe. Maybe it would be better at a later stage. We need to level the ground first, then decentralize. If you want to decentralize your wives make sure they have basic requirements like beds and so on. Give them some money-generating activities, then you can decentralize and supervise them.

As the workshop participants, elders of Osukuru and one of the experienced government policy officials have pointed out, the natural environment in Uganda is seen exclusively as a means for providing resources to satisfy people's needs with the benefits of these exploitative activities accruing to individuals high in the hierarchy of power and to international agencies who supply the science, technology, skills, and expatriate services.

Concern for the well-being of the ecosystems and of the majority of Ugandans who have depended and related to these systems reciprocally is not reflected in any of the developmental programs. References to environmental care in policy documents and in educational programs were regarded by participants as lacking in sincerity or the commitment needed to establish practical connections with people's lives and the worsening condition of the environment.

6.4 Summary

A conservation ethic, based on the concept of caring that would provide a practical moral foundation for a sense of well-being in Uganda has been shown by the various voices in this chapter as being rapidly eroded by the pursuit of modern development. In philosopher Borgmann's (1984) exquisite reflections on modern technology and its implications to the meaning of the world of things that surround us, the economic developments that made possible greater material consumption coincided with important scientific and technological innovations. With this view, science and technology wholly copied from the industrialized nations are being strongly advocated and implemented in educational institutions with a view to modernizing the production sector. As well, the same modernization paradigm was based on uneven material progress within and between nations, leading to contemporary realities of North-South inequalities and marginalization of the poorest sectors of national and global communities.

With the ecological changes ushered in by factories in their midst, the web of life has been severely damaged. The narratives of the elders, although expressing interest in some material advancement, weigh more in favor of a development which recognizes people's linkages to nature and culture.

The recommendations in the White Paper and the constitution to promote science and technology in education for purposes of development were discussed alongside insights from scholars like Fien (1990), Capra (1982) and Huckle (1988) whose advocacy for discourse that is environmentally sensitive presents a challenge towards and direction for reframing of science and technology education at both conceptual and practical levels. Similarly, participants expressed a view that educational goals in science and technology education be related to personal, social, and ecological needs if the education is to improve the ability of individuals and groups to cope with challenges of modernization that have been realized through advances in science and technology. These views present a challenge for Uganda to evolve strategies of development/industrialization which use science "to develop technologies for humanity and the environment." The idea presented by participants here is that science and technology and their corresponding development in education should operate on the basis of a 'bottom-up' approach, starting with what is already available: local people, their needs and aspirations, their knowledge and technology, and their natural resource bases.

While a number of the participants, particularly those among the urban elite, had a strong of view of development as that of industrialization and urbanization, there was a greater consensus for the support of a development paradigm that would not uproot the majorities living in rural communities from their cultural milieu.

Overall, the voices of the participants on formulation and implementation of the policy dimension of science, technology in development and environment, including education, point out poor mobilization of public opinion and participation. Some participants considered this separation of the policies and government from the wider community as related to the assumption that people are independent of each other, their culture, and nature; and that problems of development, of scientific and technological innovation for modernization, including the role of education, can be imposed on people. In their narratives, both the elders and other participants believed that poor politics and policies may well be a result of corruption or dishonesty among government officials and other elites whose self-centeredness "pollutes" the healthy patterns of accountability on which democratic government, equity and justice are founded - including the ability to harness appropriate science and technology compatible with stewardship of the environment. This is not necessarily the case. It could also be the result of an uncritical acceptance of progress and development paradigm by Ugandan leaders.

In their responses, some participants blamed the terrifying trend of environmental devastation and rural-urban poverty on a combination of uncritical pursuit of inappropriate science and technology to foreign prescriptions for economic development which have played a significant role in the corruption and dis-empowerment of the education system which is rendered impotent to respond to social and ecological degradation in a timely manner.

In a similar manner, participants also viewed the continued tolerance of widespread social injustice as having the same corrosive effects on environment and people as inappropriate science and technology, or of insensitive policies and corruption. This combination was seen as contributing to the paralysis of various individuals and groups in positions of responsibility to contemplate and bring about sustained mutual initiatives commensurate with social and ecological balance. The strong call by most participants, including the rural elders, was for a committed promotion of justice and protection of the environment. There was also a strong view that this needs to go hand in hand with the majority participation of men, women and the youth, whether in the context of a nation's domestic policies or in the design of "North-South" agreements between financial institutions and or industrialized nations.

CHAPTER SEVEN

VOICES FOR CHANGE: TOWARDS ECOSCIENCE

7.0 Introduction

This chapter presents the views of participants on the questions that have surfaced through the themes of the previous chapters. The focus here is on how science, technology, political forces, and visions of development could be conceived in education in a manner that is more inclusive and sensitive to locally meaningful objectives and action frameworks for people and the natural environment. These concerns were echoed during the Rio Conference of 1992 where world leaders, scientists, economists, industrialists, and other interest groups appealed for responsible activities and living which ensure cleaner and safer ecological systems for all, a strategy referred to as Agenda 21. The conference also advocated the building of good communities within sustainable action strategies (Lazslo, 1994; Norgaard, 1994).

This chapter offers some ideas through the participants' voices on the following questions: For science and technology to be ecologically and socioculturally grounded, what would it mean and involve? What would be the ethos of thinking, discourse and action? What implications need to be drawn for the theory and practice of education?

The responses and reflections therefore echo some of the participants' views, hopes, fears, including personal engagements that relate to an evolution of an "ecoconsciousness" which span interests towards change. We will listen to some university academics and students from Makerere and other professionals including elders of Osukuru community as they share their feelings, understandings, convictions, hopes and cautions related to an evolution of an ecoconscious spirit of living and growth, leadership, and of educational curricula and discourse that can help in creating change for sustainable futures.

7.1 Responsible Living with Nature.

In the previous chapters, we have explored and gained some understanding of how Uganda as a developing nation is enchanted with modernization and its promises of delivering people from "darkness" to "light," from "ignorance" and "primitivity" to "knowledge" and, as some authors have referred, from scarcity to abundance (Brown, 1995; Timberlake, 1991). As these scholars have noted, governments in the poor nations in the South have been marshaling their traditional societies to invest their natural resources and productive efforts using science and technology to create maximum wealth within the global market framework developed under the capitalist economies of the industrialized countries. To bolster capacity in what is called national development, education has been and continues to be one of the principal methods of socializing traditional people into visions and promises of the modernization agenda through the promotion of science and technology in curricula (Odaet, 1993; Harrison, 1992).

From various narratives of experiences shared earlier by participants in this study, we have listened to feelings of uneasiness, discontent, suffering, deprivation, cultural alienation, concerns for ecological degradation, social inequity and structural violence that have resulted from the modernization effort. Because thought and action greatly influence the kinds of environments people construct determining who they feel they are and how they think and what they eventually do it was also imperative for this study to explore the participants' thinking about how Ugandans should interpret and act in nature, and what might be the appropriate ways of educating and relating to nature, to people and their cultures for sustainable futures. Kossy, a geography high school teacher in Tororo and research assistant to this study, shared some personal experiences and feelings on the state of the environment in Tororo:

> I am right now involved in piloting a United Nations funded project called Population and Family Life Education. In that project we meet a lot of challenges especially as far as environment is concerned. We are concerned with how to help towards alleviation of environmental problems. This project involvement has linked me more with my teaching subject (Geography) by bringing me closer to the concerns of the people.
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> This has accorded me and my students an opportunity to interact closely with the realities of life of the rural people. Although I am not really a science teacher, these involvements have led me to relate with some aspects of science as I share, reflect and inquire into the state of our people and that of the environment. Now whenever I travel, I automatically tend to notice a lot more than ever before about the quality of the environment and that of the surrounding community.
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> When I notice a badly used environment, I now ask myself what could be done to save the situation. When I look at children, I cannot help seeing what kind of hardships they are going to go through in their life span on this degraded earth, particularly Tororo District. As a matter of interest, whenever we attend the project meeting or seminar, we come to the revelation that Tororo District is one of the worst in environmental quality in Uganda, second to Karamoja District.

Kossy has evolved a sense of appreciation and connectedness with natural systems and of how people's sustenance depends on a healthy natural environment. This level of valuing the quality of ecological systems would require an accompanying high quality of emotional bonding and an internally driven love and respect for nature. Continuing in deep dialogue with her feelings for the state of the natural ecosystems, she said:

> Land or air or water; land with trees, soil. If we destroy it, isn't our standard of living affected? It will. When all is destroyed, what can we get out of the land any more? Not so much. Why? We are responsible. And I have a very good example that we are responsible.
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> We were going for the burial of our nephew's wife down by the lake shores of Lake Victoria. The land there has not been seriously utilized by people like ours out here. The state of nature there! The trees! There are these *Fene* Trees (Jack - Fruit trees) the type around here, for example.
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> The one in the home we went! It is like a big, big house. The tree is so huge, Mr. Oluka. Too huge. I looked at the tree objectively. I said this tree! How has this tree grown like this? But that is not even the only one. As we were moving - thank God we were moving on *Boda Boda* (bicycle taxis) - these other natural trees on the fields. Huge! And you can see that these trees are happy. And they are old, and strong, and they are alive. They have energy! They are happy trees.
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> Then you look at the crops - the groundnuts. And when we look around there! I wondered whether it was sugarcane. People said: *that is a plantation of maize*. But you could think it is sugarcane due to its big size. And the cassava, and the potato leaves are almost like the pumpkin leaves. Wow! The pumpkin leaves which I would have in our home here, are the leaves of potatoes in that place. Moreover, they had been harvested! Everything is just having its own natural way.

Having lived mostly around the degraded peri-urban Tororo and witnessed the changes in the state of the environment and of people's living conditions, Kossy contrasts this with a traditional life which she discovered with shock and joy as having maintained some balance with the ecosystems. With this experience, it was visible in Kossy's emotional countenance displayed in her expression of voice and body language, that there is a fundamental value in having a good, natural ecosystem:

> I look at nature in that place, that is a good example. Now I do not have to struggle so much to tell these students that we have really destroyed the environment; and we are going to pay for it. Because this environment will not give us anything any more. If we had a way of reaching such places, they wont again have to bother reading books. Just refer to it outside. Such places are still there in Uganda. Let us not minimize our country in light of the poor soils, air and water we see. We are responsible for that poor soil in many ways. That should be one aspect of quality of natural resources. And we can have a quality resource if we are aware.

In Kossy's perspective, being ecoconscious requires an evolution of critical awareness to inform the daily activities of everyone. That this has not been the case for Tororo is evidenced by her reference to the deteriorating air, land, water, and people's well-being. The large scale interferences witnessed in Tororo due to industrial pollution, waste disposal, land chemical applications of fertilizers and pesticides have so outwitted peoples' capability to cope as the Osukuru women elders in a focus group discussion with Kossy explained:

> science and technology (*acoa imusugun*) is now what everybody is looking at for an answer. These chemicals are going to kill us and we do not know. These things they are spraying food with, are they good, Mr. Oluka? They are not. These rats we are killing with poison in the house, you kill a rat, two, three. I may think: *So long as I do not have a rat in my house, it is okay*. But how many more are poisoning rats? And where do we throw the rat? In the garden! Does the chemical rot with the rat? The rat rots but not the chemical. Now when rain falls, where will the chemical go? We are in trouble. This thing will find its way to water. And water we definitely need to drink, cook and wash with. We may think: *I am very far away from Lake Victoria*. You are not. You are very near it. Because all these rivers, like River Malaba. All this we may be safe from our own rat-dumping problems; but how safe are we from other people's problem of rat-dumping? We are not. This is how we are going to see that all subjects are going to be affected that is what I feel. Our experience will be very informing.

Kossy and the women elders' focus group understand that the transformation of the state of the ecosystems in the localities of Tororo exacerbated by industrial activity in the area has transformed the cycles and quality of the natural environment and of people in ways very different from what the people themselves have known from time immemorial and learned to respond on reciprocity. The sensitivity raised by the women focus group over the use of poisons is actually an indicator of their critical awareness of the polluting hence environmentally damaging effects of chemical contaminants to the environment, alongside subsequent impact to human and other forms of life. These voices clearly convey responsible living with nature, with no "NIMBY[24]" attitude. This level of critical consciousness among these participants has its roots in their lived experiences of how the "dust" from the cement factory in their neighborhood has affected people's health, decimated vegetation (Appendix 4), including the *Isukuru* (famine rescue) plant on the hills. Similarly, the effluents from the fertilizer into their only source of fresh water dried up most of the swamp, killed the fish, led to migration of wildlife from their locality, and generally affected their soil productivity. In spite of the awareness of the gross ecological damage to their land by the surrounding factories, these elders have found it prudent to stay silent about their suffering. As noted earlier, lack of contact and empathy among leaders for the rural masses reinforced statements made by politicians in support of economic development first, before environmental conservation (New Vision, 1996), the elders fear reprisal by the powerful arm of government. Besides, the Constitution of Uganda (1995: p. 5) has declared that it "shall protect important natural resources, including land, water, wetlands, minerals, oil, fauna and flora on behalf of the people of Uganda." For elders to raise their voices otherwise would contravene this power of control conferred to government, making themselves vulnerable to treasonable charges. The expressed concerns now appear to be flagged by an emerging critique of the previously unquestioned assumptions which undergirded belief in industrial pursuits as development and social liberation.

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[24] *Not in my backyard (NIMBY) is a practice of conducting irresponsible ecological behavior like waste-dumping and nuclear testing in other locations other than one's own backyard,: transferring effects of damage to (often) less informed, or powerless groups or individuals.*

With the exasperation embodied in the responses above, the questions of how to regard nature and how to think and act in nature would appear to require a re-creation of the dominant world view and action frameworks that could reverse the pressure of the current patterns. Due to the various national and international forces of social, political and economic power involved, the task is certainly enormous. Nevertheless, the participants did advance some hopes and ways this could be achieved through science and technology in education in the Ugandan context.

7.2 Linking Education with Communities

The ecological and social crises faced in most places in Uganda are real. Some reference to this was made by some of the participants in previous chapters. One renowned African philosopher considered education as a vital process of preparing people for life (Nyerere, 1967). It would appear that one of the greatest challenges of education at these times of ecological crisis is that of educating to hold something of value in trust: the well-being of humanity and of the earth. In the forthcoming discussions, participants make a call for placing service ahead of control, and not to expect leaders to be in charge. This sense of commitment, servitude, or stewardship was pointed out by Lawino, an Adult education student of Makerere, as being a principle that could engender attitudes of accountability:

> When approaching issues in local communities, and getting to nurture that transformation comfortably and sustainably, there has to be a commitment. There has to be that attitude of charity: a feeling for the people as we work with them and for the natural resources that nourish them. Unless we ourselves as Ugandans have that inner feeling, we will have nothing moving. If we had two, three of such people, some impact would definitely be made; and others would pick up from there. In a parallel comparison, look at what Jesus had in terms of success in His times: just twelve people. But now half of the world embraces some aspects of His teachings. Unless

> we have this attitude, we are not going to achieve anything. I think that is the starting point. Commitment.

The idea of having people begin to take care of the earth and themselves with an attitude of accountability is explained here by Lawino as replacing self-interest with service as a basis for claiming the freedom of the beleaguered majorities and ecosystems. She advocates emotional investment of the professionals, their preparedness to live with consequences and be comfortable even with minimum initial support. Her reference to Christianity today is mainly in relation to the considerable numbers of Ugandans who have adopted this faith. However, it is important to note that Christianity as a religious institution can have its problems of bureaucracy, social and political manipulation, and economic interests. For example, Galileo's discovery and publication that the earth and other planets moved round the sun posed a challenge to the then dominant belief endorsed by the Church that the earth was the center of the universe. Upon this revelation by Galileo, the Church came to consider science as an adversary, as it delegitimized the Church's authority to explain the meaning of existence. Accordingly, Galileo was arrested and dissociated from people until his demise (Gore, 1992). In championing environmental care, such negative attributes of organizations may not auger well for the commitment as Lawino would like to see. Among scientists, related professions and educators, Lawino's remarks introduce another aspect of what it would mean to be committed: moving forward to being creators or re-creators. As Berry (1988) and Naess (1986) both explain, basic spirituality and sense of identity are communicated by the natural world. To Berry, the loving bond associated with spirituality is reflected in the basic characteristics of interrelatedness of the different parts of the universe, each system's balance being sustainably provided by each of the other parts of the cosmos, warranting it the name of universe. Naess (1989: p. 175), advocating this concept of interconnectedness and identity with nature and among ourselves, elaborates:

> The greater our comprehension of our togetherness with other beings, the greater the identification, and the greater care we will take. The road is also opened thereby for delight in the well-being of others; and sorrow when harm befalls them.

Towards attaining a truly ecological ethic, Naess's thesis above is a powerful insight and framework which could form a foundation of normative conduct for our interactions with each other and nature. Its attainment demands, among others, individual commitment. In supporting people's struggles to solve problems of environmental crisis, however, government personnel like foresters in Uganda have tended to blame their inability to mobilize people to lack of government funding. A commitment described by Lawino would demand that they go beyond the expediency of official means to evolve qualities of stewardship. As observed earlier, the major perceived obstacle to reformative action is the tendency to externalize the problem, usually in terms of lack of facilities and finances. Lawino would implore that rather than focusing predominantly on such constraints, scientists and educators should try to work with the rural majorities to face the increasing ecological and poverty problems in the spirit of empowerment. These professionals together with the rural people need to stand on their own ground, to recover their voices and create working choices within the limitations of funding. For example, according to Kossy and the Osukuru women focus group,

> Why don't they do this on the funeral days? At the funeral there were so many people present - now when we look back, we ask why technical men like agriculturists, foresters and so on - do not use such chances occasioned by large forums to convey the message to people concerning environmental degradation? And there they would be having nice examples to give; (like): *look at that garden there, see what kind of millet we are getting of that garden; why? Because of this and the other.* People could receive such messages whenever they go for a funeral, like they do with the AIDS. These days you cannot attend a funeral at our place and they don't talk about AIDS. Every funeral whether it is for a young child or an old woman, irrespective of the cause of their death, the AIDS educators will talk about AIDS. And people like it. So why don't these officers concerned with environment use such occasions to talk to people? We don't create.

A misfortune shared by most African nations would appear to be the way various institutions, government and private, have historically been established with a clear line of authority in which decisions about policy, strategy, and implementation are the domain and prerogative of the central authority. People at the middle, like the scientists and other professionals, and at the bottom - mainly the rural masses - exist to execute and implement plans. This would appear to have smothered initiative, a trait lamented by Kossy as missing among professionals like agriculturists, educators, and foresters. It would appear that this structure and practice has become so entrenched that, to Kossy and the women elders' focus group,

> We Africans, when you are leader to organize something, the other people, tend to leave everything for you. They just see and look only at you as responsible, and whatever you say is the correct thing; but no one again sees things differently and says. *Why don't we do it like this?* That means we African elite are lazy and tend to get satisfied with very little.
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> Then there is also need to grow attitudinally in line with all these concerns, so that they know that we need to do something about this environmental problems. For example, they know that Tororo is one of the worst hit districts as far as forest destruction is concerned. But when they sit in their offices there, do they ever ask: *What can we do?* They are not inventive or creative. They think what they have read in the book is enough. And now they are hanging on to the reason that government has not given them

> money for the field work they need to be involved in. But there are ways to do these things without having to wait for government to avail funding. So we need to give ourselves time for the work we are supposed to do; be obedient but also be creative. Not just in classroom but if we can do that outside; if these children we are going to teach come out with such attitude, such mentality they would be more creative, more responsible by the time they would be old like us; you will see change in the rural life. There will be a change. We should encourage this positive creativity.

This is a very strong demand for loyalty and commitment to service by the rural women elders. In the view of the elders, a process of socialization into uncreative and uncritical "respect" and "leaders" has led Ugandans to feel passive and disempowered. As was seen earlier in the field of education, the orientation of university science programs, school science curriculum and emphasis on examination grades likewise show how an authoritarian management culture has helped to sustain a hidden curriculum of domination by elite managers.

The sectarian spin-offs of an authoritarian model of administration have operated to ensure that the concerns and plight of the masses and of the environment have not found a sympathetic location in higher and other levels of educational curricula. Any attempts made to include the themes of science and technology organized around schooling, communities and environment, would appear to be out of scope or out of hope because, as Lawino observed:

> unfortunately all these decision makers are products of the same educational system. Many of them are also happy with the status quo. Most of all it is interest in money other than commitment to the needs and aspirations of the rural poor that attracts NGOs and other groups or individuals to work in the rural areas. That is why you find that many people who work in matters of rural development are those who are out for jobs and wanted a placement where they can live and survive. The same with other professions. People just want money.
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> In Uganda, I do not think that we have reached a point where the universities' research on advanced technologies, say, related to space science. Our universities should focus research and teaching on basic living situations of our people. I would like to see the faculty of agriculture that is going to be discussing the ox-plough, how to grow maize, how to use farm-yard manure - using what is indigenous for the indigenous. That is what I would like to see the higher institutions do. In completely blending this, I would like to see the university student not going to Kabanyolo Experimental farm for agricultural practice, but rather they should go and live in a peasant village during the digging season for them to understand the science of the hand-hoe and production. We in Uganda must learn that westernization is not the only model of development. We can take on an indigenous approach like some countries in the East have done and be more helpful to our own people as well as grow by building within our indigenous cultures.. I also understand that scientific and technological

> innovation in Japan even among the children is superior to some rich countries in the Western world. This is because these kids in Japan are playing and using more of what is around their culture and environment than having to copy western blue prints of science and technology.

To Lawino, stewardship in science and technology in education has to do with preparing people first and foremost to care for the earth and to foster a consciousness of interdependence of people with each other in their cultural milieu. She sees this as the "missing link" in the educational system in Uganda, and in Makerere university's engagement in abstract teaching in science and technology not grounded on Uganda's felt needs. Lawino also challenges a science and technology which has no roots on culture or indigenous knowledge. Her central concern is a science and technology which would reverse the increasing human isolation from the ecoweb; technologies which are appropriate, cheap, and accessible to the majorities to facilitate the redress of increasing ecological depredation, increasing poverty and widening social disparities. Equally disturbed by this design of science and technology which omits ecological care, Neddi, a high school science teacher, expressed this feeling:

> Instead of waiting for specialists educated and working in universities to come and learn about these environmental problems and fix them, we only need to lower these things so that it is mentioned at all stages of education right from primary one. Let nursery children sing songs or rhymes about environmental problems, their causes, even if they may not know. Small, short rhymes. And this means that government should take control of education right from nursery. And let it be education for all. For the communities that have not gone through the formal educational system, they also need to be taught. The government needs to start a rigorous campaign, and learn to spend money on education, on information, on communication so that it levels this knowledge in the country.

Neddi affirms the need for critical awareness of the majority of citizens so that they can begin to actually participate in policy, rule-making, and education for environmental care. He noted the potential limitation and weakness of centralized control in environmental policy strategies:

> If you want any success you must integrate a complicated system where there are many players, it is the most stable and most reliable approach to use because when one element is displaced from its position another one takes over, and nullifies the loss of the other one. But when you are the only one person playing the game, when you collapse, the system collapses.

This idea would comply with thoughts earlier submitted by Kossy and Lawino, pointing to the need to provide what Toh (1996) calls partnership and meaning in education at local, national, and global levels. Neddi's latter remark also explicitly rejects the common assumption that various sectors, or in curriculum terms, various disciplines, have nothing to do with one another. Neddi explained his disappointment of the current impracticability of "integration" due to the fact that the subjects are, as much as anything else in the country, bureaucratically and institutionally defined. This setting has provided that teachers are licensed to teach a discipline with various scholastic materials in a school structure similarly framed around disciplines.

It is important, however, to understand why these tendencies prevail in Uganda. As earlier discussed in the literature review and by the participants, the intellectual community in general has not overcome its dependency on external (invariably colonial-induced) frameworks of knowledge and practice. But there is also an equally serious element of poor conditions of service for university and other civil servants in Uganda (Olupot, 1995; Ajayi, 1971). This drives academics to seek alternative income sources with whatever spare time they have. Put together, intellectual dependency and poor conditions of service create scenarios where identification of alternatives becomes very difficult. Thus the call for commitment, stewardship, empowerment and partnership as previously raised by Lawino, needs to go beyond simply academics and other professionals to higher institutional and government structures. The very nature of stewardship and partnership may not easily be tenable in Uganda among those who thrive in the status quo, because stewardship and partnership have in common the wish to minimize bureaucracy and, as Mercogliano (1996) has advocated, to seek greater interdependence among communities through redistribution of power.

In his optimism for a science and technology for communities, Neddi made a strong observation on possibilities for mobilizing support from communities to get input in terms of ideas, particularly indigenous perspectives, organizational strategies, as a process of defining direction:

> We educators need to go to communities, to mobilize them, and let them share their problems. They know soil erosion. They do not like it. But they do not know what to do. They are blaming nature, they are blaming God. They say: *the end is coming. God is tired of us*. They are suffering from many diseases caused by environmental problems. They have dysentery, they have cough, they have worms and so on. They have a lot of malaria. They can contain these problems. People who are employed in that area are too few and demoralized. In some cases, we have to use a multi-sectoral approach. We can draw programs that talk about sanitation, environmental degradation, etc.; and income generating activities. Sensitize all these Local Councilors and opinion leaders first. Then people come and we have a form of syllabus and government officials at district level seeing to its implementation. People can come and contribute. It should be discussions with people, not an imposition of ideas on them.

To reorient science and technology to answer the felt needs of the masses in rural and peri-urban areas, Neddi's remarks relate to partnership and the advantage it poses in tapping the resourcefulness of communities that could make a useful contribution in stemming ecological and social crisis. Viewed in this light, the principles of stewardship make the people in power and those endowed with scientific knowledge to be accountable to the needs of the people, while partnership balances responsibility.

In his book *Small is Beautiful*, Schumacher (1973) drew attention to the pervasive influence exerted by the choice of technology and the need to make alternative technological choices available. In the developing poor nations of the world like Uganda, a range of alternative technologies embedded in the traditional/indigenous activities have existed and evolved from the stone age. Contrary to dominant thought about the independence of science and technology, the essence of Schumacher's vision is that neither science nor technology is a fixed or a given factor in socio-economic development. Rather, each is an instrument that has historically been adapted to harmonize with the economic, social, cultural, and ecological systems in which it is introduced. A similar call arose from the study participants about science and technology, arising out of local culture, with community members being active participants, as Neddi asserted:

> Let there be village committees to handle this. After all, people have known their problems on environment like energy needs and sanitation. They know and live with poverty problems. They should formulate ways of overcoming them, there should be committees for each of these, elected by the members themselves. Then there should be models in every sub-county. Government should acquire small plot of land - it is a model home - build one. They can get donors. Suppose you integrate into a small model homestead: water filters, village refrigerator, a toilet, these things for hurling maize, solar dryer, the modern granaries, integrate all of those into one village; plant the trees along-side all these other activities. Then next to that, the formally educated who have been spectators of problems of development in their villages should be encouraged to move downwards to their villages and be living examples by sharing their expertise.

An indigenous approach to development based on appropriate science and technology is not a new concept. As both the WCED (1987) and the Global 2000 reports indicate, time is not on the side of the poor majorities in the South. Having been outcast by modern industrialization and market systems, the poor in the South much like the minority poor in the rich nations who have stooped down to produce what they do not consume and consume what they do not produce (McRobie, 1981), these societies would be seen to assert themselves by harnessing science and technology to enable them to become self-reliant and earn a decent livelihood through living and working where they belong.

In spite of the above support of science and technology for rural communities' problems, a parallel need in education to pursue and keep in touch with developments in mainstream science and technology was sounded. This was expressed by Amooti on a cautionary note:

> Let us not make a mistake, you and me. Though orientation of science towards our traditional perspectives must be a necessary component of our science and technology curriculum, we should not stay away from the mainstream pursuits of science and technology. I feel we must also forge ahead in this direction, for if we do not do it, nobody is going to do it for us. It is good to run at village level, but occasionally you must show your flag at the Olympics. If you do not do that, you may never get any visitors in future coming to assist us with community work. So we still have to measure up to the high technology area.

This is a realistic suggestion given the potential of scientific and technological innovations, put to proper use, to address processes of food production, storage and distribution in nations with increasing populations; problems in medical treatment; energy resource needs and a range of other needs. When successfully implemented, Amooti's view is an antidote to technology transfer. The assumption is, however, that there will be funding locally or readily available to facilitate this objective, as previous accounts have pointed out. On a short term, it would appear that emphasis on appropriate science and technology may be more useful and affordable (Jamison, 1994; Franklin, 1990; McRobie, 1983; Schumacher, 1973).

Establishing a science program that allows the poor majority participation in the struggle for life in ways that conform to their needs and for ecological sustainability requires a balancing built upon the majority's priorities. For a country like Uganda to measure up to the tasks raised in the government White Paper (1992). For example, that "Uganda must henceforth seek to establish the highest quality of education possible as a basis for fundamental change, revolution and national development" (p. xiii); and that since "no education nor country is better than its education" (viii), the latter point is an important observation to which educational planning and practice should be duty-bound to appropriately respond. Amooti's uncertainty is justified given the rigid structures and the way science and technology in education are framed as mentioned earlier. Second in the wider context of global forces, as Bhalla (1994) asserts, few countries in the South today are both producers and consumers of high technology, convincingly recommending an internal capacity to evolve technologies in order to reduce their dependence on the industrial nations. The capacity of poor nations to support an indigenous-capacity building in science and appropriate technology is currently weakened by the international economic environment and the structural adjustment programs, establishing yet another cycle of dependence on institutions like the World Bank and the IMF. The challenges of these implications to institutions of learning and scientists and educators in particular are great, but perhaps not insurmountable. The subsequent sections present some possibilities.

7.3 Contextualization of Science and Technology

Besides the constraints defined by the international economy, the of indigenization of science and technology has also an epistemological problem which institutions of higher learning are probably best placed to inquire into and formulate locally meaningful frameworks. We have seen earlier that in indigenous settings, "science" and "technology" form a continuous and harmoniously interdependent knowledge forms. In what ways could formal science respond to such indigenous communities' understandings? Amooti, a national science specialist and policy consultant on science and technology in Uganda, shared this view:

> I must admit it is a kind of question that should concern our university education system at this time. Some of us unfortunately get appointed into responsible positions without a clear understanding of these definitions, meanings and implications of science and technology. I think people need to know exactly what it is that we are talking about. There are those of us who approach these things in unique ways and think there is nothing unusual about carrying them into school. Personally I do not see anything wrong with carrying science and technology as one. I am sensing the rest of the world also waking up to this idea. In UNESCO the concern now seems to be that of promoting science and technology in their advocacy for science and technology for all. Definitely there is no way that you can carry scientific literacy independent of technological literacy, and vise-versa. One may think of these two as being distinct spheres, but perhaps only for the purpose of concessional formation for people who work in technology and those who work in science. For an average person doing normal things we think that science and technology are the same; they are two sides of the same coin. They are about you dealing or interacting with materials or matter, aiming at doing or getting something for situational applications.

In Amooti's personal opinion, the educational curricula need not treat science and technology as though they are totally incompatible systems of knowledge. The preferred picture to Amooti is that of an interconnected network of knowledge, techniques, and social interactions in which knowledge is translated through techniques to action. This notion has support from Leiss (1990) who views technology as a synthesis of techniques and concepts and modes of social reproduction. Seen in this perspective, the significance of science and technology in terms of being vehicles of innovation in human societies could have a deeper meaning and coherence if carried as an integral part of educational discourse.

Apollo, a professor at Makerere University, had some sympathetic remarks regarding exclusion of traditional community participation and indigenous knowledge:

> ...if we discussed technology within the context of the local environment, where possible even use the local language, it would be most beneficial to our communities. There is a wealth of knowledge out there. Consider for example things like making the spare parts of an ox-plough. Before we started importing polish on a large scale including their spare parts, the local people knew so much as to how to make their own implements and spare parts. They were cheaper and probably more suited to their needs. For example they may want a part shaped accordingly; or some degree of sharpness; and they have learnt to make these parts with accuracy and in a manner that is easily replaceable. In this regard, I therefore think that massive importation is obscuring some of the ways of doing things. When it comes to methodologies and mitigation options to present environmental problems we face, may be one of the things that could be done is placing a laboratory in the rural settings. This will allow for tying-up of two approaches: The remote laboratory which depicts distant thinking to on-spot solving of the problems that you now get participation of the end-users. Their input is going to be there. They will come and see what you are doing; or perhaps you are giving them a product. They test it; it is brought back for further modification within their own environment. Yes, I agree that there is a wealth of knowledge out there. (Interruption).

Apollo acknowledges the need to include participation of rural communities in discussing science and technological programs that have a direct bearing on their needs. The approach, however, seems to separate the processes of "making" and "using". The hierarchy and isolation of design, development, testing and final use of implements is a recipe for dependency on a higher authority, thwarting creativity and initiative. On how to promote reciprocity and a sense of creativity and initiative among the rural participants in these community outreach efforts, Apollo said:

> We need to use projects, and these projects have to be based there in the rural setting. Of course in the initial stages these projects should be developed strongly based in the laboratories here at the university. Then this laboratory could then move to the end-users' location. The difficulty is the background of the people you would like to interact with may not be very conducive to productive interaction; but since we want this rapid acquisition and merging of these forms of knowing and doing things together with the end-users, it is us to adjust. Now in particular, there is a relatively reasonable level of literacy in the local villages, making communication, and identification of key players or participants much simpler in many respects. For example, if you have a photo-voltaic system which requires charging batteries, maintaining them and so on, I think today's participation at village level, you will be able to get at least one person who will be able to functionally operate and run the equipment. Workshops should also be brought into towns and villages so that a large number of people can be drawn-in the first instance to participate; but also so that the rest of the people see and appreciate, because it is a communication system that we also need to establish to create awareness and interest.

Not only could this effort lead to support and alleviation of the day-to-day needs among the communities, but could also be a major success story towards indigenizing and cultivation of values of reciprocity in scientific and technological inquiry and practice. Writing on this issue, Berit Ås (1975) prefers to look at *planning* as those strategies that aim at maximization of profit or gain, and as *coping* with those strategies that are designed to anticipate and prevent disasters. The distinction between the two is related to the notion of context. This debate relates to the notion of "objectivity" hence the way science and technology in formal discourse accord positivist treatment to social problems. To Ås, strategies to minimize disaster demand a critical understanding and recognition of context. Of particular importance is a consideration that context is a variant, and that every feasible response will trigger a counter response which reshapes the situation to the extent that subsequent decisions have to be made in iteration to the shifting nature of context. Prescriptive planning typical in science and technology, on the contrary, assumes a stable context and predictable responses. It also assumes that planning protocols or strategies can be transplanted from, say industry to education, without any repercussions. It is such possibilities and understandings that interaction with traditional communities may instill in formal science. That is what Apollo seemed to allude to, when he said:

> It is this approach of penetration which, I think, is required. But now the science aspect means that when you get the final product, you are delivering services. If you develop something from a given locality, then you have developed it for that specific locality. You need to see to it that your model of approach, the methodology, is such that you have developed a system of supervision until that technology has matured in that particular locality. Some of the problems we run into is rapid transfer. If you develop a system in one area with donor support, the tendency has been that the donor or some policy maker will demand that you quickly change direction and shift to another place. This has a tendency to put you into a situation that you will not have learnt any lessons before you actually get into mass transfer. So I think allowing the technology to mature in one specific locality where it was developed is something we need to build into our practice.

Having lived and taught for many years in rural Africa, interacting with the problems, anxieties, and joys of the rural communities, a Norwegian Physicist Endre Lillethun conceived an innovative idea of supporting science and science education programs in Makerere University through a Norwegian National Committee for Development Research (NUFU). In this program's rationale, Lillethun (1992) framed the mission of the NUFU aid to Makerere as to facilitate the "evolution of science programs that would enhance technical advancement relevant to the needs of Uganda." (personal communication) Such a support program by NUFU offers Uganda, through Makerere University, a clear opportunity to avoid a scenario illustrated by Donald A. George (1981) where the "typical student ends [an] education with a distorted view of science and totally no concept of technology. And yet this is the student's preparation for the 21st century." (p. 22).

To contribute to alternative perspectives of science and technology would therefore require science and science education to move away from the narrow perspectives of a narrow reality imposed by disciplinary discourse, making scientists inadequately prepared to deal with increasingly complex environmental problems of the century ahead (Norgaard, 1994; Braddock, Fien, & Rickson, 1994). This makes a serious case for urgent exploration of opportunities and possibilities for alternative frameworks of science. For, as Capra (1982) notes, "our multi-faceted cultural crisis" urgently augers for the "need to adopt an extremely broad point of view and see our situation in the context of human cultural evolution." (p. 25). Similarly, Suzuki (1994) argues that with the worsening ecocrisis, humanity needs to reconnect with the natural world from which there has been much estrangement due to increasing dependence on modern science and technology products, emphasizing the need for a massive change in attitudes, values, and beliefs.

Sharing his views about how Uganda could engender a science education which could foster responsible living with nature, one of the key science educators and researchers in Uganda, Mwalimu, had this to say:

> Right now we have practically non-existing teaching materials which reflects that kind of science in social issues; science and environment; science in developmental issues and even science as applied to technology etc. We have very little of this in text book form. In some text books you may only see a picture reflecting technological advancements, pollution, but with little discussion of how science and technology have been used to get to that thing shown in the picture. There is no written material to explain the relationships between concepts and practical applications in meeting needs. So that's our biggest problem is to produce enough materials so that our children begin to see that science is not only concerned with those facts which are explained as everlasting. It is also concerned with human issues, and social issues as well. We have to get our teachers to get in the habit of writing materials and when they produce these materials; and these materials should be abundant.

Orr (1994) offers some helpful insights by pointing out the need to re-educate people into existence. This process...

> ...must be scientifically literate enough to recognize politicized science for what it is. It must be courageous enough to face facts squarely. It must be committed enough to avoid the seductions of cheap citizenship. It must be intellectually alive enough to demand careful and thoughtful analysis of public problems (p.126)

This totality proposed by Orr should become involved in the creation of occasions in careful and incremental ways with tremendous sensitivity towards what he calls the "totality" of the occasion. Within this framework of social intervention, whether it involves curriculum development or rural and/ or urban development, the critical concern should be the capacity for all the participants to share in the imagining and creative development of what shapes their future. Chambers (1983) has noted exemplars where indigenous science and technology help to inform modern scientific knowledge, and the failures which result when indigenous knowledge is ignored. Significant in Chamber's analysis is the need for participatory scientific and appropriate technological development to focus on three main concerns. First, it is essential to raise the level of critical consciousness of people, leading to a lessened dependency on outside forces represented by technocrats and their respective institutions. Second, it is necessary to safeguard indigenous science and technology as well as improve them. Third, it is useful to make the existing "appropriate technologies" genuinely appropriate, in access, usefulness and ecological considerations. And finally, it is important for people to participate in technical discussions which broaden their critical awareness of the interactions between scientific, technological, social and environmental issues at local, national and international levels such as energy, pollution, sanitation, clean water, food production, nutrition, and population.

7.3.1 Education's role in the Contextualization of Science and Technology

To redress the isolation of rural majorities in science and technological discourse and of the now prevalent ecological deterioration in Uganda, universities as centers of intellectual empowerment have a crucial leadership role. Pointing out how science programs at Makerere University need a big orientation to attain a level of cultural and ecologically viability and sensitivity, Wakki, an economist and mathematician at Makerere university pointed out:

> One problem in this university and that of our country is that we have nothing to build on. All our professors and most senior persons studied abroad, and do not have our own problems with a history for which to build on.

Wakki is expressing concern about how, despite all its good intentions, the teaching of science is cut off and disembodied from active life and experiences of people, divorced from social concerns, and hence denatured. In his view therefore, science as currently structured and taught in Makerere university has diverted people's attention from asking situational questions. Wakki strongly believes that there is a general flow in science and technology in education in Uganda demanding urgency by scientists and science educators for he said:

> To rediscover and define science. Science is not manipulating Maxwell's equations. Science is what led Maxwell to those equations, in terms of what he was solving, and what the use of the answers are. But look at what we subject the students to in this university: manipulating equations, proofs, and so on. While they are nice analytical procedures, I think we miss the point of need to rediscover science. Secondly, we must have policies and strategies which will make some rediscovery come to fruit. This university now therefore needs to define its function, and to do this, it has to review the mission itself: how this mission should be interpreted in the programs offered. Our education system is simply insensitive to what is appropriate in our settings. Who should think for us?

With Wakki's contention, the university should begin to locate its mission of knowledge generation to fit the larger landscape of learning, with focused consideration to questions like "what", "for whom" and "why" certain expertise being developed in the university are important and what the wider ecological and human prospects are in various programs. Wakki's views therefore demand that university science scholarship begin to be geared towards engaging students, teaching and research efforts to inquiring and explaining the ethical, social, and political implications of their various participatory endeavors. So the question that now arises is: What can scientists and science educators do to evolve a science and science education that could practically respond to ecological and socially meaningful developmental issues and needs of Uganda? Wakki saw the first move as that of understanding the age long stigma, that is...

> ...the division between science and arts as arbitrary. It depends on what you want. Very arbitrary. That is why I am so mad at our system, that a kid at senior five has already decided that he is a scientist. Because of all this he will not read other critical books. He wont read history books, but wants to read only science-related materials; does not read about culture; does not read language; does not know how to write expressively. That *because he is a scientist!*

Wakki advances a view that the revisioning and rediscovering of science should see scientists and science educators taking greater interest in wider issues that relate to society for which the specialized knowledge of science is hoped to serve. His reservations for specialization tie in with Ortega y Gasset's (1957) reflections, that specialization limits scholars' ability to solve problems. In the case of Uganda, most physicists should, for example, have the capacity to make practical contributions to energy problems in the country. The disciplinary division of science and other subjects is a historical construction tied to division of labor for which intellectual production followed suit. What we can derive from Wakki's argument is well analyzed by Fien and his colleagues (1994) on the need for disciplinary border-crossings. To some degree, specialization in various fields of intellectual inquiries is desirable, but what concerns Wakki is the absence of intersections of the range of "knowledges" as an attribute of the holistic formation of intellectuals.

Loma Bon, a Sociology of Education professor with a keen interest in development education in the South contexts, provided other considerations with respect to the disciplinary debate:

> We have to clarify our perception of science as a society if we could be able to answer that question about what role science could play in social and environmental harmony and sustainable development. I think it's important to point out that science is not above us. Science exists to solve the problems that we face. To my mind it is important for us to be clear about that. We don't put it as something above us - something to worship as it seems to be case in most of the poor societies. We must say it is something which is below us, so that it must serve the needs of our people.
>
> It should be, as it is, socially defined. My fear is that if we see it as something to worship, something which is supernatural, we shall put it in wrong use. We must be emotional to each other; and love each other and our environment. In that love, science must therefore come in to help us to promote that harmony. But we cannot promote that love if we think that science is superior to us. If it is superior, then there is no way that it can come out of us. It cannot develop out of us. Viewed this way we cannot develop it; it is outside so we must wait for it to come from there.

Loma Bon's remarks bring to mind the objectivist vision of scientific knowledge which assumes science as distinct from people, as earlier raised. This concept of objectivism of science constitutes Karl Popper's *third thesis* or *world 3*: a cosmos of science with which humans can only interact (Miller, 1985). It is this vision of science that Loma Bon expresses a discomfort for, arguing that it gives science an independence from society to a point of being treated above humanity. What Loma Bon notes about the autonomy given to science and scientific discourse has also serious implications to scientific applications, namely, technology. We can therefore argue that neither science nor its applications are preordained; rather, they are choices to be made based on participatory frameworks in the service of the needs of the majorities.

The entrenchment of disciplinary framework of science was noted by Loma Bon as reinforced by an approach of teaching and learning practices that...

> ...see science to be a system of knowledge which we have to pursue strictly in school. In schooling itself, right from the Ministry of Education to the classroom-teacher and a child in a class, the thinking is that science is system of knowledge which can only be accessed through a lab. The view is that science is a laboratory inquiry also applied in a lab setting. Practicals have tended to be focused towards getting the students to pass

> examinations. When the practicals are done in the laboratory, the highlights are to achieve excellence in conducting or showing those skills of manipulating devices, specimen and materials to achieve expected results by the teacher and or examiner; and this child has to strain to do that in order to get the grade.

This is a concern for a pedagogy which promotes memorization for earning grades. It is an educational ethic which Loma Bon believes thwarts internalization and contextualization of science. What Loma Bon feels grossly ignored by a dominant laboratory approach of teaching science are the interactions with the community as ways to share indigenous perspectives and concepts. As argued in earlier chapters, contextualization of science requires curriculum reorientations that do not fracture students' interactions with realities in communities, but actively engage laboratory-based inquiries with real-life situations of communities in ways that lend immediacy to learning. This orientation to learning makes it possible for science to be understood as a response to the circumstances of life of the majorities and of the state of the environment. Such a view and practice of science discourse also lends itself to a learning process which is more than a means of passing examinations. Rather, as one science teacher in the workshop shared, students "focus on whether what they are seeing or have witnessed will appear in the examinations, and how it is likely to be set; and not in terms of what has caused the problem they are looking at; or how people are suffering because of that problem; how the problem could be solved to ensure that the people are peaceful" (Koku: a high school science teacher). The systemic structuring of science and the focus of education on examination achievement was, to the participants in the workshop, a great influence in keeping science and technology away from attributes of love, intelligence, wisdom, virtue, responsibility, value and good sense, socially and ecologically.

Scientific and technological contextualization of knowledge generation and dissemination, which focus on the performance of important responsibilities to the planet and to all its inhabitants, are also opportunities for African communities to resourcefully engage indigenous knowledge, skills, attitudes, and values as was pointed out by Loma Bon :

> ...there are two systems of knowledge, one of which is promoted in a school system and it has got its practices. There is also a system of knowledge outside the school practiced by those who have not gone through the formal education system - what we call indigenous knowledge. How do these two systems relate? In my mind the indigenous knowledge itself is scientific. People produce food which we eat here using their indigenous science, not using that science which is acquired from this formal system. So that system of knowledge needs to be linked with the system of knowledge in the school.

In the contemporary picture, indigenous knowledge in science is desecrated and desanctified, often being dubbed metaphysical or too romantic. This fundamentalist view by scientists would prefer a science decloaked from passion and emotion. Orr (1994) has a suitable response to this vision when he problematizes this form of scientific fundamentalism as not being scientific enough, but rather "a narrow-gauge view of things that is ironically skeptical...[therefore in itself] unscientific, about science itself and larger social, political, economic, and ecological conditions that permit science to flourish in the first place" (p. 45). To this analysis one can add that the emotions, triumphs, myths and tragedies that indigenous knowledge is associated with and often accused of in the scientific and technological community is what gives strength to indigenous knowledge: history, identity, contextuality, ambition, wonder, and its own sense of curiosity. A helpful guide here is William James' idea on what it takes to humanize a subject: "You can give humanistic value to almost anything by teaching it historically. Geology, economics, mechanics, are humanities when taught with reference to the successive achievements of the respective geniuses to which these sciences owe their being. Not taught thus, literature remains grammar, art a catalogue, history a list of dates, and natural science a sheet of formulas and weights and measures." (Quoted in Postman, 1995; p. 113).

Organic linkages with cultural domains still available in all areas of Uganda are seen by Wakki as a way to evolve science programs that will instill ecological competence:

> The past generations managed their nature better than us. What we need to do is to harness whatever useful aspects of whatever they were doing and make these more efficient for our times. The word is efficiency; it is also the word which evokes scientific questions. So the concept of efficiency is for me at the heart of science. We have, however, to think about this concept of efficiency very carefully in relation to our current and future need.

How, then, could the qualities of these two systems of knowing get sufficiently understood, coordinated and put to good use? What kind of relationships emerge? Loma Bon had some thoughts:

> ...we bring that knowledge from the indigenous setting to be interrogated in the classroom and laboratory using modern science and vice versa. Because what we're doing here is using modern science to enhance the understanding which the community has. So the two actually are acting in a reciprocal way rather than competing.

With the focus being:

> ...to utilize the principles of modern science in order to develop our science, the indigenous science, to solve problems of society. The two forms should not compete. The school and community should try to develop a unified science but depending on and using principles of modern science to improve the other. For example in farming, the people in rural areas as you all know have got a fantastic understanding of the environment and its problems. They know how to rotate crops, protect the soil fertility, and so on. Now given the principles of modern science as we have learnt, how can we utilize these principles to investigate deeper, these kinds of beliefs which actually have led to some kinds of skills and activities of these people?

Pointing out potential shortcomings of an approach which will appear to expose merits and demerits between the two forms of science, Loma Bon cautioned on the competitive model inherent in modern science. He identified the danger of pitting the indigenous and formal science in a competition which would reinforce the division between the educated and the uneducated. This division has been the problem of science for a long time in Africa, providing a possible reason why modern science and technology have not transformed the majority of society on the basis of equity and justice. The current model of science and technology in education was also assessed by the workshop participants as directly breeding dependence on the rich North for imports. A necessary caution in the contextualization of science is the use of the North as role models as this would go towards sustaining the modernization paradigm (Toh, 1996). This sensitivity was evident among participants in the workshop, for Loma Bon pointed out:

> we have remained a country that imports science; and it is only in places like where we're now. That is the problem I'm seeing and it encourages consumerism and dependence. We're simply consumers of technology. That technology is not necessarily suitable for our people. You can see we have built a school like Tororo Girls, but we cannot cope with this school locally despite the availability of scientists, engineers, etc. We can't solve the problem of the school falling apart. That's what in my view, if we're to deal with questions of environment properly, our interests should be to deal with problems of society holistically. To develop science with technology. That should be the guiding principle. That technology, once it is of our own, it will be useful for us.

Gandhi (1948) referred to this unified process as education by craft, insisting that education arises from life itself through doing what one must in order to survive. For Gandhi, this meant craft work which would then serve the child, the family, and the community as an economic resource. So unlike the busy work in science and technology prescribed in institutions of learning like Makerere, Gandhi's notion of craft is not a mere exercise detached from life, but a vital and rich means of participating in the life of the community. In this light therefore, engaging formal science and technology with indigenous knowledge could facilitate an emergence of a curriculum from the relationship of the learner, educator, the intervening concepts, skills, attitudes, and values with other participants, and with the natural world. Among the traditional rural communities knowledge and practice are intertwined. Thus interaction and participation with rural communities appear to be a fundamental demand placed on the prevailing formal curricula in science-technology representation. Kossy's discussions with the Osukuru women offered this reinforcement:

> Our people are scientists and as far as farming is concerned, during my interviewing, one of the respondents was heaping her potatoes. She was describing how she plants her crops to prevent soil erosion. She said: *with potatoes we don't heap in lines like the people in town do. We heap rough, rough,* (at random). (Laughter). Then I asked why. Then she said: *if you heap like that* (in rows) *the water will just collect and wash away all the soil. But this way the water will remain there and seep into the soil.* So I thought that was a wonderful knowledge of science put into technology at the same time. I am a geographer who knows and has taught about soil erosion for thirty years. If you go to my gardens of potatoes, we have never heaped potatoes at random. They're always in neat straight lines. So we're just promoters of soil erosion. Here is a scientist, an ecologist and technologist or engineer in the village. So technology is really something which rural people always live with and use simultaneously in doing their normal work.

Ordering and categorizing things and activities is one of the processes of a scientific way of doing things (Harlen, 1992). It is one of the attributes formal education and the whole process of learning has worked very hard to socialize and legitimize. Kossy's remarks above testify to this. Her interaction with the elder woman in her garden exposed to her a science that people grow up with a science intertwined with their daily activities whose epistemology would seem to embody holism. In this context, formal schooling in Africa would appear to have availed a different representation of science, particularly in process and facilitation. But school science and discourse, because of the political and structural support it has enjoyed, has determined what is accepted and passed as appropriate science and its practice and as science for development, including who uses it, how and when it should be used. Amooti, a science specialist at the National Curriculum Development Center, and a policy advisor to the Ministry of Education on science and technology in Uganda was keen to raise attention to these ramifications and their impact on the general outlook. He said:

> A lot depends on our own history as individuals and as individual educators: the way we were taught the science we're talking about. We've only one earth. I don't see any other earth in which we shall go and therefore we have to think in terms of presenting this science for development of the human species but also in that same environment where we happen to be. So may be we have to wake up to see that it's not only a

> question of learning science but being educated about using it to develop ourselves and to sustain ourselves; sustain the very best of that sustenance, which is environment. But you can see that it means we are really learners ourselves. We were brought up in informal science in our communities; then in the formal science education in the schools, which science education may not have been necessarily oriented towards sustainable use of the environment.

With the increasing crisis of ecological depletion, it is the sustainable use of the environment which could drive the integration of the formal science program with indigenous knowledge. In Amooti's view, critical identification of environmental concepts, ethos, skills and the encompassing issues into science and science education calls for concerned educators to individually introspect to discover whether they, in very basic terms, are adequately prepared to teach science which is good for the environment as well as for appropriate development. On the question of development, one of the contesting perceptions relate to following the industrialized country model, as opposed to say, one based on self-sufficiency and internal integration. Wakki's view was:

> I am afraid that high technologically driven agricultural production and industrialization is what our planners would call it development, but I think that is commercial development. Wanting to see huge houses, huge factories, roads as done in Europe. We want to see our people withdrawn from the villages and work in these guys' industries and say we are developing; but who is benefiting? What are we surrendering into? This form of development is going to cost us dearly.
>
> The environment! The people! *I tell you we are going to pay through our nose.* To import this technology, whether it will come or not ... I don't take part in it. It took Europe many years, and they took a lot from many places too, to come to what they are today. It is there in history books. We cannot take a similar route. We need our own. Whether moving villages into towns is going to work for us, I do not know. Europe was not copying anybody at the time like we are seeking to copy them now. They had their own historical, social, resource and other pressures which evolved into what they are today. There are no happenings in the social arena that are independent of these factors.

A critical task for educators as role-models of educational and research leadership in this country, in light of this response, appears to be that of making a contribution to appropriate choice-making in terms of what development means and involves and how choices are made for the benefit of all, with particular attention paid to saving the environment.

This introspection would demand an ecologically driven thinking in order to evolve a critical edge on how science and technology would improve the quality of the environment and the life of the people on a sustainable basis. This understanding among environmentally conscious scientists was acceded to by Amooti when he pointed out:

> You as scientist in a world economy, creation of wealth should be looked at from a different perspective. By creation of wealth, given that you need materials anyway, and that you must be converting some materials from one form into another form, you must know that you are in no way adding any naturally desired materials on the surface of the earth as nature would have it. As a scientist you must know that you are perhaps utilizing natural resources which could have been better kept around in the form that it was before than the form now we end up with after you've created the famous and much demanded wealth.
>
> So when you say creation of wealth, how much of the environment are you leaving at our disposal to do other creation of wealth later? What options are you providing or leaving for the future generations? These things need looking at.

To Amooti, scientists or technologists have not created any new matter. Rather, they should spearhead ways of living in light of the fundamentals of the laws of thermodynamics, namely, that matter and energy in this universe is fixed, and that industrial transformations may create an imbalance of matter-energy availability in ways that are harmful to the earth's inhabitants through resource depletion as well as pollution. Attaining this level of critical understanding and critique as scientists and science educators and coping with these discursive perspectives demands an interdisciplinary capacity and framings. To achieve this, Amooti suggested an approach of...

> ...revisiting science to make sure that we present better science than we have gone through ourselves. Putting into that science a little bit of an orientation towards learning the science for the environment - in addition to learning from the environment; in addition to learning from the environment; in addition to learning about the environment. There is also learning about our fellow human beings or people and their occupations in order to get our terminologies right, instead of having rigid definitions of what it is we study in science. We should begin to see some of those definitions as used by the other discipline which previously were not able to do science.

In an educational system that has a conservative history, this revisioning is not without problems, some of which Amooti identified as lodged in the Ugandan scientists themselves who...

> ...have always tended to look at science as being so many subjects. When you say 'science', people say: "You mean biology" "You mean chemistry" "You mean physics". We have to begin saying that whether a chemist, biologist or physicist, one has to be a good scientist. Unfortunately the specialists in these fields never think of themselves as anything else other than physicists, chemists or biologists. If you listen to them carefully, you might discover that most of the time they are thinking about their own areas

> of specialization as being science. Hardly do they see that science is beyond their own area.

These insights about a revisioned science to incorporate caring and consciousness for e[illegible]systems with a sense of empathy, responsibility, and accountability clearly conform to what David Orr (1994) advocates as a worthy goal: ecological design a process and consideration to be built into all ways of doing things as a means to care for this planet, Earth. Hence, instead of internalizing and contextualizing what has already been discovered and written about, science programs in Uganda need to establish an internal political support and sensitivity to limitations in science and technology and engage in a simple but nationally useful research and educational agenda. Hinting on how this could be achieved, Wakki offered:

> We should learn to go into the history of things if we have to advance them. I do not care if an American professor will say it is not part of physics, but if a student has been able to trace the history of a technology, or of a scientific concept, how it evolved, and is able to extract some aspects of these to solve a particular problem here, and gets an answer that is useful to us, that is wonderful. We now have a human resource that is familiar with what needs to be known on this subject. Whatever happens elsewhere should not matter to us. This is ours. So in that context for me, it is worth doing. To us, people who think like the western people do would consider the attempt to get into history of things as lack of creativity, lack of originality, hence no contribution. That is how they would take this effort. But they are failing to understand the context under which you are contributing.

There needs to be, therefore, a deliberate search for occasions in which understandings of *what is* and or *ought to be* informs and relates to science and technology in dealing with people's expressed problems. There should be inquiries into culturally located activities that enrich and broaden the social and ecological value of knowledge, as Loma Bon pointed out:

> The kind of things we are talking about here will require that the students are taught about how science develops. But when you look at the syllabi which we use, I do not think whether there is any direct discussion with the student on how science develops, so that as they go into rural settings, there is a certain foundation on which this is based; they have an understanding that there is science in villages, and they stop looking at London as a place where science comes from.

There is a legend about the capture of the ancient city of Troy where the Greeks could not penetrate the Trojan defenses. They therefore designed a giant horse in which they hid their soldiers. Impressed and uncritical, the Trojans took the magnificent wooden horse into their fortified city, only to lose it later that night to the Greeks who used the cover of darkness to open up the city gates for the big invasion. If only the Trojans had been critical of the heavy Greek wooden horse gift! The above reflections by the study participants carry a note of caution to Uganda with specific reference to the ways science and technology and their role in development have been merely accepted as an answer to all the people's needs. To Loma Bon, Wakki, and Amooti, Ugandans are probably better off creating their own sense of science and technology constructed to suit indigenous epistemology and concerns; and, these underpinnings are a vital ingredient for a liberal education which a university like Makerere should pursue. While some participants strongly critiqued modern science and technology there have been many areas in which applications of modern science and technology were, and will continue to be, crucial like health care, communications, disaster response, and environmental care.

In order to make a decisive impact as genuinely dynamic and useful process for transformation that responds to the needs, resources, and aspirations of the masses, a people- and nature-oriented science education in Uganda will require a values dimension in its programming. Scholars like Fien (1990); Braddock, Fien & Rickson (1994); Huckle (1988); Toh & Cawagas (1990); and Kreisberg (1986) are among the many advocates who call for schooling to embrace and disseminate a mission of education which should reflect critical awareness of and empowerment to act on social, economic, environmental, cultural, and political issues, systems and structures. In light of the above ideas and experiences raised by participants, Uganda will need to address itself to an education programming that has built-in components of peace, social justice, environmental care, and a culture of participatory and cooperative endeavors that also link with grassroots communities' and organizations' efforts in order to affect the policies and actions of centralized government and unresponsive bureaucracies.

Another option that offers Makerere University an opportunity to link-up with communities is the adult education program. Makerere University has an Institute of Adult Education the mission of which is to bridge educational and social gaps while at the same time build up broader educational gaps from below. At this study's workshop, Loma Bon, responding as a university academic engaged in the teaching of some Adult Education programs, provided an inside picture:

> For the moment, from what I know the issue in the eyes of the politicians, policy makers and even educators, the problem and complaint is that the people do not know how to read and write. To them therefore, if these people knew how to read and write, they would be able to adopt the science and technology that we teach in schools; that is what they are interested in. It looks to me that the main problem is that even the adult education that we conduct in this country is really influenced by the other problem: the diploma disease. The Institute of Adult Education in Makerere University is also geared towards getting certificates, that's it. The only useful form of adult education that I am aware of is the one being attempted by some of the

> NGOs, those that are with the *real* people out there in their settings; trying to educate and help people solve problems practically and gain literacy in the process - that literacy that is useful in defining and solving the situated problems faced by these people. At least the program I know and the one I teach and made reference to earlier, that one is a different adult education than the one I want to see take place. Because the participants in this current program are already OK - the problems they are seeking to solve are monetary and have been solved for most practical purposes compared to the average rural or some of the urban persons.

The reality with the university-coordinated adult education programs is therefore not very different from the mainstream education system in terms of widening the gulf between a small and English-literate middle class and the mass of the people. Hence, for both formal and adult education to have influence among the poor nations in the South, there is need for them, as exhorted by the participants, to become part of the life of the people, springing from their own felt needs, not something merely "laid down" by governments or government maintained agencies.

There was a strong feeling among the participants in the workshop that the Uganda government should take committed moves to facilitate mapping out a genuinely liberal education aimed at developing the full range of human capabilities to combat marginalization, exclusion, corruption and intimidation.

This commitment will require substantial government input. Neddi pointed out what the situation is like in teaching:

> That is why when our governments in this country neglected teachers, there is a lot of public outcry; there is a lot of fear over what a neglected educational system can deliver for the country. Fortunately, the parents came and owned it indirectly by contributing to salaries by more than one hundred percent of what government was paying teachers. And if there were no parents responsible for owning the problems in schools, education would have collapsed in Uganda. That is my guess.

Continuing the dialogue, Loma Bon said:

> The other thing which the government could attend to is to improve the conditions under which teachers live. When you look at the few teachers in this country, they are the laughing-stock of everybody, of all workers. The conditions have gone so low, so that when this is combined with the fact that there are no facilities, you come to class to teach students physics you cannot even take them anywhere, creates a lot of frustration which is ultimately transferred to students. So I suggest that in addition, the government should allow the evolution of a coherent teachers' union. Union that is in the hands of teachers that unifies them. One of the our big problems as teachers is that we are fragmented. The Uganda Teachers' Association (UTA) as it has been since its inception does not care about teachers. I do not know what it is for. It is also funded from out. A teachers' union would help bring teachers together. These issues like the

> ones we are talking about. We would talk to teachers about the curriculum as we have done today here. We would talk to teachers about our social conditions. There is no better way to bring influence towards politicians as a way of generating national consciousness. That could be one way we could easily and immediately address this issue. I am glad that the Deputy Commissioner of Education a few weeks ago encouraging the unionization of teachers. That would be one useful step.

These steps, perceived and pursued with egalitarian thinking in support of the majorities, can motivate educators to join appropriate fora for discussing issues of environmental quality and possible educational responses. Authoritarianism in education in Uganda has a wide range and scope. On the teachers' platform for example, Mamai said:

> Unfortunately what I discovered as a participant representing one of the science teachers' associations during discussions held on an educational project proposed by a foreign agency is that nobody would like to hear about what the teachers are doing. I was so surprised that whatever we said as teachers' associations was brushed off. Some official *on top there* in ministry headquarters wanted the project to benefit them than the teachers' associations.

Historically it would appear that effectiveness of educators at any level has been defined in terms of their ability to satisfy the prescribed demands of the profession which have been understood to mean excellence in didactic teaching of the prescribed curriculum in ways that ensure high grade results from students; and an unquestioning obedience to "authority." The explicit outcome of the system has tended, up to this point, to be professional compliance to such approved behavior and performance. Insensitivity of some Ministry of Education officials to concerns of teachers as noted above is typical of an authoritarian, self-centered educational management that thrives on bureaucratic manipulation of the powerless. The perennial reward system in Uganda expressed by the participants is a very unsatisfactory and demoralizing one leading to low esteem and a sense of being disowned among teachers. The challenge voiced here is for the government to create remuneration practices that support the heart of stewardship, which is accountability and commitment to the well-being of the teaching profession.

7.3.2 The State and Ecological Sustainability

Having to do with who gets what, when and how, the ecological depredation and biodiversity reduction experienced by all nations, rich and poor, is increasingly a symptom of a political crisis. The centrality of politics in what Orr (1994) refers to as ecological and sociocultural atrophy is not a result of ignorance. Many governments all over the world know enough about the depredation of their ecosystems and its implications to the biodiversity and the lives of the people. The environmental impact of massive dams, clear-cutting of forests, and toxic pollution are some such common but serious issues ironically initiated by governments, and now requiring the institution of governments to intervene. Numerous cases are documented exposing failures of governments worldwide to conduct environmental impact assessments on various ecologically damaging "development" projects, often triggering public protest (Suzuki, 1994). Public protests have been the only means adopted by people to get some attention and, in a few cases, remedial action from governments. However, some have resulted in violent clashes between the awakened majorities and the powerful arm of government, as the well known Saro Wiwa 1995 incident of Nigeria demonstrated. Such incidents reflect the grotesque reality that the public has to risk intimidation, coercion, even death, to take national leadership to court to make them do what they are, by law, supposed to do (Nietscmann, 1987). Besides hiding behind the state military power and an unjust law systems, most nations in the South are enchanted by the belief that all damage to the environment is reversible through the power of modern science and technology (Norgaard, 1994). Few governments appear willing to openly challenge the elite economic forces and interests that maximize their profits through environmental unsustainability.

The science front may have the relevant concepts, skills, and may even provide for the evolution of appropriate technologies that could redress some ecological damage. However, without the political blessing which comes with its distribution of wealth, land ownership, organizational power, and legitimization of public business of any kind, science is immobilized (Bookchin, 1990; Suzuki, 1994). As narratives above have indicated, ecological issues are large, complex struggles against goals and practices which undermine biodiversity and ecological and sociocultural harmony. The failure to effectively foster environmental conservation efforts particularly arises from both inadequate policy formulation and implementation. On a national scale, for example, Ugandans should raise questions about whether there is any legislation on the quality of the environment; which parties have participated in making regulations regarding environment and what the focus of such regulation is. These concerns were raised by Loma Bon in the joint workshop:

> We have the Ministry of Environmental Protection. About one month ago, they appointed a National Council for Environmental Protection. I think that's what they call the National Environment Management Authority from what I know. My concern now arises from what we've been talking about. The detachment between the educated and the people who are supposed to effectively run the major environmental problems in this country leads me to question the authenticity of legislation in terms of defending the interest of the people.

The extent to which the policies and the corresponding legal provisions arise from the expressed problems of the people themselves is crucial to ecological and sociocultural harmony in two ways. First, it would provide for increased opportunities for majority participation in reflecting upon what is important to Ugandans, including the common dependence on the ecosystems. Second there is the opportunity for clarification and revitalization of the role of science in national concerns.

As previous expositions of participants have shown, there is a large communication gap between scientists and the public, and between the scientists and politicians. This abyss is attributed to the processes of alienation and depersonalization of science dominated by a positivist discourse and practice. Scientists essentially fail to relate and anchor the concerns of the masses as a means of effectively informing and marshaling their majority support for ecological quality and to locate ecological deterioration in political discourse and national planning.

Stymied by instrumentalist interactions, peer pressure, and cherishing what Kuhn (1967) has called normal science, scientists fall short of what Havel, quoted in Orr (1994), proposes as a viable path towards avoiding divisive and short-term technical fixes to problems of human and biotic collapse:

> ...We must draw our standards from our natural world, heedless of ridicule, and reaffirm its denied validity. We must honor, with the humility of the wise the bounds of that natural world and the mystery that lies beyond them admitting that there is something in the order of being which evidently exceeds all our competence. (In Orr, p. 72)

These provisions pose a challenge back to the interaction and strength of the feedback between education and politics. Creation of critical awareness about ecological crisis has to do with taking interest in environmental science and the to deeper underlying causes driving forces which relate to political and economic institutions, values, and attitudes. Furthermore, it means making the project to save our ecosystem a joint and collaborative endeavor of science and politics. Scientists need a leeway to free discourse with communities, institutions, and other dominant forces without fear of intimidation or real harassment. To establish realistic and socially just goals for ecological literacy, responsibility and accountability will demand a vibrant will from all Ugandans to give and take, and to evolve a curriculum that will functionally relate to these objectives at all levels.

7.4 The Role of Women

Inquiries into women in education during the 1970s is characterized by a focus of what is now popularly known as "gender and education" (Luke and Gore, 1992; Maguire, 1987; Sjøberg, 1988; Harding, 1986). The effort of such explorations was driven by the need to expose classroom and pedagogical inequalities between male and female students, and the implications on career gender imbalances. The pedagogical research efforts relating to gender in education had a view to establishing balance in curricular construction and implementation. In the last decade, interest in gender research has percolated to national commissions and into educational policies. In Uganda, the White Paper (1992) on education has clearly identified a need for women's increased access to education in general, with science- and technology-based programs and careers having a strong emphasis.

Makerere University, under what is called the *affirmative action* program, has engaged in a deliberate process of positive discrimination in favor of females to bolster the number of graduate women in various sectors of the job market (Mulemwa, 1993). Among this program's initiatives are, in the short term, an increment of 1.5 points to female university applicants to raise their opportunities for admission to professional science and other degree programs at the university. The university has also launched a graduate degree program in Women Studies, with one of its courses being 'Women in Science and Technology.' According to one student in the Women Studies program, the central focus of this course is on inequalities of access of women to science and technology-based careers, women's experiences in science courses, women in industrial development and related comparative studies based on formal science and technology as currently represented in the curriculum.

As one of this study's focal interests, a holistic vision of development based on social and ecological harmony must incorporate the participation of women as vital and central to its success. Accordingly, the study had interests in illuminating rural women's perspectives and to explore possibilities for alternative theoretical and practical groundings of pedagogy that is contextually sensitive to multiple interpretations of the majority women's world beyond the confines of "objective" science and technology.

Discussing the issue of women in education in general, the Osukuru women focus group expressed support for an all round education for girls and women on critical issues like *what* it means to be a woman in these times:

> Girls' eyes need to be opened. A girl needs to know what she is going into, and prepared conceptually and emotionally for life. At present children are just growing *like that* (anyhow) and they just meet things, and they crash on the wall. Especially girls. They just take things wholesome. Enjoying themselves, never asking: *after this, what is the result?* They do not look at

> the end-result of whatever they are doing. They only see what they are doing now. This is what educational programs should expose students to: the problems, issues around them, and then consequences of various behaviors, attitudes and activities seen in everyday life to which they are vulnerable.

This response has multiple readings. First, there is a serious concern over the *laissez faire* attitude of girls, with particular reference to the exploitative and manipulative social relations with men which she elaborated as having led to undesirable early pregnancies and school drop-out for most girls. On an emanicipatory level, the account speaks to the indigenous framework which has historically obligated a man to support his wife and children, challenging it as ill-equipped in the contemporary dominant market economy, seeing the traditional husband-wife relationship as subjugating to the wife, making her economically dependent on her husband. This defines the woman's status as subordinate and inferior, calling for what is popularly called empowerment. In other words, as called for in the gender and development field, there is need for the empowerment of women.

To a number of scholars, empowerment needs a sound ground for its construction. Gore (1992) in her discussion of this subject points out that while meanings can be identified and tied to discourses, "empowerment" tends to presuppose an agent of empowerment; a notion of power as property, or a given; and a desirable goal. The Osukuru women's response above may have a goal, but certainly exposes a lack of agency or social environment in facilitating attainment and experience of this power. Least of all, the elder women focus group seem to see themselves as the very conduits of this experience of empowerment.

Within the formal educational framework as it is, Nadda, a science university academic and PhD scholar at Makerere, hinted on some attributes of empowerment attained by women in formal education:

> Which educated woman in her normal senses - even if she is not a University graduate but educated up to advanced school certificate level will want to produce fifteen children? For what? It is the population expansion which is the root cause of our problems in this country, so how do you address this problem? You must educate. I think education is number one. It must be a priority in every forum or agenda in government, leave alone Makerere University. Makerere's "1.5 system" is just a tip of an iceberg. It does not add much. These are people who are already literate anyway. Even if they do not come to the university, a girl who has attained Senior six is sufficiently alert to issues. If you are exposed to family planning, you know how to take care of your family. At least you can appreciate some level of good living; good standard of living. The level at which a student reaches senior six she can manage her own affairs critically.

This may assume that "good living" is always congruent to some level of educational attainment independent of other factors like economic and social structures which could still potentially operate to disfavor women at work, family or community. But what kind of education can help women to develop a consciousness for transforming their lives? To Nadda, educators should awaken and inspire critical thought and sensitivity of women to the potential and real sociocultural, political, and other shortcomings faced by the majority of women. One needs to ask whether, in higher institutions of learning, the process of education promotes understanding of marginalized groups, particularly women or simply greater insensitivity. Nadda shared her experience as a female, gathered through being an undergraduate and graduate student at the faculty of science in Makerere:

> You know we are disadvantaged in so many things, discriminated over so many issues. Personally I think the teaching disfavors no one specifically. It is not gender sensitive. Because when you sit with your colleagues, you either concentrate or your mind is wandering away thinking abstract things. That is nobody's business. In the final analysis, either you pass exams or you fail. Having gone through this university, of course I am aware of some cases where some ladies, because of being what they are, have faced problems from male teachers or that sort of thing. Personally, I have not experienced it, but I know my friends who have come to me and confessed that they have been harassed by male teachers - you know social problems. This is mainly at undergraduate level. When you come to graduate level, a lady in science arena is a loner. In my area of wild life, many people think I am a lunatic.

Giving reasons why, she narrates her friends' view as arising from her engaging in...

> ...combing forests, spending many days in the bush, dressing manly, sleeping unkempt most of the time. Many of my girl friends think I am crazy. I have found that some men are encouraging, but there are some who are absolutely terrible. They see you as a challenge and like to create a barrier for you. I particularly faced that when I was doing my MSc. research. It is through my stamina that I persisted in what I was doing. Naturally I am stubborn, I like getting things my way. This is what kept me indifferent to sarcasm from a guy who was really out against me. I had these unpleasant experiences, and one day I had to confront this guy and told him off. He was somebody very senior in the staff. I was not being harassed sexually, but this fellow wanted me out of the program. He did not want to see me accomplish my research in the field. One day I burst out and went and talked off my mind, promising him I would not leave whatever he did to me unchallenged, and told him to leave me alone. He saw I meant it and left me alone.

According to Nadda's narrative above, we could tentatively say that Makerere university, with its elite bias in programs and teaching, is complacent in addressing social attitudes that affect minorities like women in science programs. To be publicly or privately pursued as being 'disagreeable' or 'misfit' when engaged in normal scholarly activities clearly constitutes a violation of the rights of Nadda, as is increasingly acknowledged in the case of women and other minorities. It is probably a situation best described by Hannah Arendt in her reflections on 'Stateless People': "The point of giving refugees legal status is to make them deportable" (Quoted in Bat-Ami Bar On, 1996 p. 293). In a similar argument, it would appear to Nadda that women in education are, being a minority, isolated and vulnerable to exploitation and manipulation by those in control or in perceived superior status.

Insensitivity to equitable treatment of women in education could be said to arise from the laxity of accountability and responsibility of educators. Accountability and responsibility, as carried in the analysis of Hoyle and John (1995), are two distinguished rather than confounded terms. In professional contexts, Hoyle and John relate accountability to being answerable to procedures and outcomes often determined by the codes of the profession itself; and responsibility as encompassing, but transcending, accountability because it involves choice and judgments particularly in uncertain and changing situations. In the context of empowerment of women in education within the above experience of Nadda, professional knowledge and practice at Makerere has no accountability measures for academic staff on the gender gap, leaving the 'dissident' voices of female students to emerge in isolation. It would also appear that there is no initiative from the university academe to assume responsibility for female student concerns.

In an emotionally moving account, Sidel (1987) has provided a picturesque description of the sinking of what may have earlier been considered unsinkable: the Titanic. She has pointed out that while women and children were the first to be saved during that traumatic event, the disarming reality was that only those in the first and second class were saved. The majority of the women and children in the third class did not have the chance to survive.

The conditions in the present global economy and of education are in no way different from the Titanic experience. With all the glamour and power it promises, the globalized market-driven economy and the technocratic education present "a face value" similar to the Titanic's unsinkability, an infallibility, omnipotence and omniscience. Parallel to Sidel's informing ruminations therefore, while there are increasing industries, hotels, cars, Bingo halls and Casinos in the poor nations like Uganda, there is a glaring lack of "lifeboats" in terms of appropriate science, technology to assure the survival of all when the Ark splinters in the deep waters of modernization. Education, in particular science and technology education, as gateways into the global economy have the trap doors locked; the decks hierarchically barricaded; and policies that sieve-out the poor, particularly women and children who become the first to suffer social, economic and cultural marginalization. And yet a truly empowering education for women in science and technology "for all" could have a pivotal effect in ameliorating ecological depredation in Uganda. It was Nadda's optimism that:

> Women as you know infiltrate every arena, in the kitchen, gardening, classroom-teaching, banks and many other positions. Given their sensitivity and emotionality, they take issues more seriously. I find men less serious unless something touches their personal interest and affects their life, that is when they tend to show commitment. Women on the other hand are emotional, of course being too emotional is bad, but I find it amicable in the sense that in environmental issues, when thinks something is going to affect her family, she gets concerned and will seek a remedy or if she can avoid it, she avoids it. An enlightened woman in the kitchen would certainly use environmentally friendly devices. That would help the society in which she is living, as long as she knows the benefits of that knowledge and practice. The other thing is that women, whether formally trained or not, are teachers. It begins with their toddlers at home. When well informed, they are the ones to impart this knowledge to their offspring. That is one advantage we have in the society, right from grass roots. You know, women are very sensitive.

On the contrary, Nadda had observations on the dominating and exploitative drive of men over nature as evident in many activities in Uganda:

> When I was doing my research along Mityana road, I was very keen to see who the charcoal burners are. Within my two years of study in this area, I discovered that there was only one occasion when the whole family went to collect the charcoal: the man, his wife, and the children. Otherwise the guys (males) are the ones wholly involved most of the time. I did not find out whether women hire men to do charcoal burning for them, but I find arguments that men do this to sustain their family. But you will find that ten out of a hundred men give this money for family maintenance; otherwise all goes for booze. Most families in Uganda are being maintained by women. The women themselves do not engage themselves in activities that are environmentally unsound like the active felling of trees. They participate in using the charcoal and fuelwood, but that is not their mainstream means of earning a living.
>
> I know that all able-bodied rural women engage in agricultural production, that is how they get their money. If you leave out these activities of charcoal burning and so on, and go back to soil conservation, the women are the ones tilling the land and tending gardens. Teach them more about soil conservation and you will have done a lot for the environmental quality. There are so many things related to environment that women do in a caring manner. The poachers are usually the men and when they get that money it is for selfish pleasures like drinking, smoking and "chasing" other women. Of course there are a few who cater for their families. Whatever the utilization of the poaching products, it is illegal.

To Nadda, the advantages that could follow from enlightenment of more women on conservation needs would show in the way resources are used on a daily basis. It would also be an important achievement in educating for the future. Efficiency, caution, and savings are such positive feedbacks of women education in a science that has a cultural and an ecological design, as Nadda points out:

> ...much as I still use charcoal in my house hence violating environmental rules, but this is conditional. I have a cooker in my house but I have banned my girls from using it because I find that I cannot afford the electricity bill. My use of biofuel is, however, an efficient one for I use an efficient charcoal stove which minimizes the impact on environment resource base. This is out of my awareness of our depleting forest and vegetation cover. It also saves my money in the final analysis.

But how many more women will have the same privilege of exposure to this critical thought for making informed choices related to environmental resource use in Uganda? Does simply having more women in education solve the crisis? An important dimension for reflection on these questions relating to education in Uganda surfaced during this study. Responding to how an increased participation of women in science and technology assures their emancipation and contribution to socially defined problems, Lawino, an Adult Education student at Makerere University and has experience working with women and development in rural and city slums unveiled some insights:

> In principle and for moral considerations, yes, we may need a balanced number of men and women working in various professions, particularly science and technology which currently predominantly male-dominated. But this does not translate into actual work on the ground.

Explaining why not, she said:

> Because this woman will also be the product of the same system that trains the men. They will tend to look at themselves like the men have done. One thing we also have to note is that the decision to go and work in the rural areas where there are all sorts of needs - name it, has nothing to do with one's being a female or a male. It is an attitude which (accrues to) both males and females in our current system.

Lawino has an insight into the bigger picture of the role of education. In her perspective, simply having more women participating in science and technology within the modernization paradigm would tantamount to enhancement and reproduction of the dominant role of science and technology. According to Lawino, more women into science and technology in the modernization framework will serve the selfish and dominating corporate interests like market-directed industrial development, wealth creation, aggressive competition, and not those of the liberation of the poor masses nor of the needs to save the environment. Lawino's stand affirmed that the current discourse of science and technology propagate attitudes that compromise ecological recovery concerns. Lawino's response exposes her reservations for frameworks of education which will reinforce the domination of nature which does not sit well with the growing sociocultural, political, and economic problems witnessed in the Sub-Sahara Africa region due to continued reliance on development initiatives which are material- and profit-oriented. To Lawino therefore, increased women participation in science and technology needs to be based on a broader and critical perspective of science and technology that is grounded and centered on the sociocultural and ecological sustainability as factors that shape our immediate living and meaning. Lawino insisted:

> You see, this is a new concept where people think the woman is what will make a difference. I want to be frank with you. I am a woman, yes. But I also happen to know how the education system is structured. As soon as the woman moves along the ladder of social class, she will equally begin to reason and to behave like the men in the system. I know so many women who are lawyers, agriculturists, teachers, medical doctors and so on. When it comes to deciding where to go and work for example, they equally decide like the men, saying: *I am not going to the rural area because there is no road, there is no hospital, there are no ways of making money*, and so on. This is how they decide. So just taking them for higher education is no guarantee that it will solve the problems we face - including those faced by the majority of women and environment.

To Lawino, it is conventional among the formally educated people including women to perceive service and well-being only in terms of incomes, North infrastructure and possibly availability of advanced industrialized patterns of consumption. She, in particular, sees the educated women socialized the dominant worldview, like the men, as equally being unable to grapple with the concerns for reciprocity, self-provisioning as in the simple lives in the rural areas in Uganda.

Like development, education in Uganda was to have helped to create the well-being of all, not just part of the developing nations' peoples. In line with Sidel's account of the Titanic, for women in the first and second class cabins of society, formal education could be said to have delivered that promise. Like development that focused exclusively on a model of progress derived from North economies under an assumption that an advanced consumerist style of progress was possible for all, the North paradigm of education has perceived ignorance and underdevelopment only in terms of lack of formal schooling and a lack of modern science and patterns of production, distribution, and consumption (Boserup, 1970; Olupot, 1995; Mazrui, 1992). In a similar tone, according to the Development Alternatives for Women in a New Era (DAWN) (1985), the impoverishment of women and the environment among poor nations has arisen out of continued assumption that insufficient and inadequate participation in development and education necessary to attain it is the cause of women's increasing under-development, and not their enforced but asymmetric participation. Particularly where they bear the costs but are sidelined from the benefits. Lawino's very profound insights raise concerns over the perspectives, interests, and value-functions that are embedded in the education as crucial determinants for true emancipation of women in education. The submission of this study is that a revolution of ideas is needed through a critical research and review of the concept and role of education and people's liberation. This is not to subvert education of women, but rather to clarify the dominant thinking that women, independent of men and the whole society, need emancipation. The biases of elitism, scientism, gender, and paradigm orientations need to be critically evaluated through dialogue within and among different groups as a fundamental search for a safer ground for dealing with dualism through more enduring virtues of peace, equity, and justice as briefly discussed in the next section.

7.5 STS, Environment and Peace

The whole of natural creation in its different manifestations of life forms and other physical phenomena and associated cycles present some form of violence to each of the other components of creation (Berry, 1988). Besides these natural processes of ecological change often experienced as catastrophes is a dimension which is of human origin in which the functioning of the natural systems of the earth is increasingly exploited to serve increasing consumer needs of humanity. According to the World Council of Environment and Development (WCED) (1987), these human-planet relations have triggered inter-human tensions creating social and ecological imbalance and, with it, conflicts and peacelessness.

Rapid modernization of societies world wide, fueled by industrialization, consumerism and global communications systems has enhanced personal, social, and ecological disequilibrium. These range from health, disorders due to drug and alcohol abuse, impoverishment, social stratification and pollution of the ecosphere (Harrison, 1992; Brown, 1995; Toh and Cawagas, 1990). Peace is therefore a multidimensional entity shaped by integral issues of militarization, structural violence, environmental care, cultural disintegration and human rights abuse.

The association of socioeconomic crisis, famine, environmental degradation, and decline in social services with increasing tensions in Africa is well documented. Timberlake (1991) has for example, analyzed these tragic events and how they are a consequence of increasing militarization in Africa and how the supply of arms by major industrialized powers support their African clients and raw material suppliers. This lamentable high levels of trade in arms in Africa is equally fueled by the demand exerted by the individual African governments, civil or military. Ugandans have had a protracted experience of militarization and dictatorship and its effects on the quality of life as Neddi, one workshop participant in Tororo, stated:

> Governments, instead of concentrating on protecting us, should also concentrate on developing us. I would like to elaborate on this point. Young nations like Uganda here, a very young and poor nation, wants to brag also when they meet other old, big nations as though we are also adults internationally, yet we are just like teenagers. Instead of accepting when they meet other big nations that they are young and that they should learn from those other countries that have existed for two hundred years or so, compared to ours of thirty four years. We should learn from those big nations. Although all nations are equal, some are older than others, and therefore should be treated as elders. I think on this matter, our nations, called developing nations, should concentrate on developing their people instead of going too much into international politics. When you talk of protecting us, from who? Is there really any country trying to disturb us? Instead, (I feel that) we (as government) have tried to disturb them.

A young nation, like a young body, needs to nurture and strengthen its internal structures, its "physiology" and "anatomy" for a sustainable cohesion and consistency. Neddi sees African nations' involvements on matters of peace and security outside their boundaries to a point of using national revenue and rare resources as inimical to national interests and the dignity of citizens. The resultant diversion of public resources from basic needs like on health and education, infrastructure, as well as deepening the foreign debts only marginalize the poor majorities further. In its report on world development, the World Bank (1991) noted that almost fifty percent of the African nations spent more than 2 per cent of their gross national product (GNP) on the military in 1987, with a third of this number spending less than 2 per cent on health and education.

The elders of Osukuru whose parish has a common border with Kenya just across the River Malaba expressed dismay over political excitements that have arisen over the years about security:

> Here in Tororo, the Kenya border is just near here a few kilometers away from here. I lived here for many years since I was born. I have never seen a Kenyan on his own accord who wants to cause problems to me. They come to marry our girls, we marry theirs. It is that relaxed. Actually these so called *security* frustrates us when we want to go there and pay our dowry the other side. We the ordinary people are more cooperative than the governments the politicians. That national security and international cooperation should be really be inverted commas. This idea of buying a lot of arms as we have had in this country is just because we are trying put the cart before the horse. Instead of solving our local problems, we want to concentrate on disturbing other nations, commenting on their affairs, and so on. There we actually invite them to cause problems to us, then we really are forced to buy arms to protect ourselves. Otherwise there would be no

> need to buy those arms if we were concentrating on our own affairs here. But maybe we want to concentrate on other people's affairs as a distracter to our own problems here.

In militarization, the "cart" and "horse" are transposed relative to those of a civic setting, and countries are shaped to act like a "fighting machine." This means that the 'junta', as is popularly known in high Ugandan circles, have tended to think in terms of allies and enemies, patriots and subversives. To this extent, military rule not only displaces democracy but smothers - through overt and covert means - the element of participation, replacing them with legitimization by force. A reason for this is suggested by Turok (1992), when he points out that military rule is a confusion of discipline and arbitrariness. Turok continues to identify arbitrariness associated with military rule to be arising from the dissociation of power from accountability, demanding instead an exacted emphasis on obedience. In this sad state of affairs, however, the rich industrialized nations are not innocent in the evolution of battlefields, ecological damage, and poor conditions of life today among African nations.

From the times of the cold war where African nations were polarized between the Soviet bloc and the pro-industrialized capitalist powers right through this day, it is widely documented how rich industrialized governments have been tolerant of regimes that have had a history of association with their international policies in spite of persistent violations of the very principles of democracy on which the big powers continue to use as platforms for waging some of the battles fought in the last decade. The Gulf War of 1990/91; the armed conflict in Bosnia and some of the power struggles in the former Soviet Union republics and Rwanda provide examples (Edmonton Journal, 1994a; Edmonton Journal, 1994b).

There is a global dimension to insecurity and peacelessness of not only the people but of the ecosystems and respective biodiversity. Besides the unfair accumulation through over exploitation, of natural resources by the industrialized countries, there is a huge expenditure on defense and space exploration. These nations, among whom are the G-7, could help poorer countries by cutting their defense budgets and those other expenses on space exploration. To Mzee, an elder and educator at the workshop:

> If USA just spent zero money on defense only for a single year, and that money was used for education, for awareness creation, for environmental conservation in Third World Countries, there would be a lot of environmental and social improvement. Unfortunately, this is not inviting to USA. They are not interested in telling anyone here how much they are spending on their defense. Even Uganda will not tell you. But it is a lot of money. I think there is no single country, perhaps Switzerland, which does have spend heavily on defense. I think in every national budget, defense

> tends to take the greatest proportion, even among poor nations. In the richer and bigger nations it is a lot of money involved in defense. I would think this large defense budgets are to safeguard greed and selfishness in pursuit of wanting to survive more than others. They want to eliminate the enemies, the enemies being those who threaten their global power position. The rivals feel the same. So they are busy planning to eliminate each other, hoping that one disappears while one survives. Each one feels it should protect itself.

In these scuffle of national interests the environment is not in the equation, making humanity the greatest threat to its own existence. Anything dangerous in this world appears to be poised to destroy one part of humanity in favor of the other; or to outcompete the other and let one survive better. In this process, a lot of natural resources have been used and put to risk. So at international or national level, money spent on defense is also responsible for environmental degradation (Shiva, 1991; George, 1976; Suzuki, 1994; Lovins and Lovins, 1980).

To the Osukuru elders, the onset of modernization - a transposition of values, attitudes, and practices with centralized state monitoring, industrialization, a monetized economy, and formal schooling -- led to departures from the previous times when traditional indigenous social institutions in Uganda operated to assure fairly and consistently stable social conditions. Among the educated and employed in various government departments and industry, the Osukuru elders expressed awareness and misgivings of their physical and or emotional dissociation from traditional ways of living; some to a point of seeking alliances with peoples from other ethnic groups through marriage, land, and homestead acquisition in foreign locations.

On a point of entry into a peaceful and reassuring social set-up to encourage and sustain attraction and valuing of *Kau* (the ethos of togetherness, interdependence, respect, love for traditional institutions and people, the land, and all its being) by the youth, elder Katan was specific:

> there are people amongst our communities these days who have no respect, valuing, and love for people; particularly those who have advanced economically, educationally, or are prosperous in their employment, politics and so on. These people are responsible, in their jealous attitudes, for some of the fear among our youth who have advanced in education for example, to return and associate with us. Some of the murders witnessed in our amidst have arisen out of these jealousies by such bad elements amongst us. In my mind, for us to encourage love and appreciation of *Kau* among our youth, it is vital for us the rural people to show and share love for people. If my brother has a child in school, let it be my responsibility to show love, respect, and acceptance to that child. When all families show this attitude to such a child, and others, those children will value us, and will always look for all opportunities to be in our amidst, wherever they may be, and will also wish to come and build among us. On the contrary, if I choose to be abusive, treat a child with cynicism as he or she grows up, will that child

> choose to be my neighbor later in life? Secondly, the children should be taught our traditional ways of life as they grow. Importantly, they need to be taught our traditional agriculture, our medicines, told about our heroes and their achievements.

In the elders' reflections, what is needed to create, express and sustain love and nurturance is role-modeling among the adults. The elders felt that their modeling will help create a positive environment for the youth to learn social and cultural competency in all their relationships. The elders also had high hopes in the current National Resistance Movement (NRM) government which has shown, since its assumption of governance of the country in 1986, opportunities to reclaim some of the traditional ways of living. Giving an example to this effect, La Patan said:

> We have the village councils where each nine households elect secretaries for security, information, people mobilization, women, finance, and youth. These councils link-up from village, parish, sub-county, county, district and national level. Now we can take charge of our security needs, hence build-up a sense of a socially defined and monitored form of governance, with opportunities for central government interventions through police, and civil courts.

The element of self-governance is, according to La Patan, attractive because:

> It is no longer a distantly located law in some books governing me. Anyone misbehaving is charged, disciplined where necessary, and monitored by the people known to him. Any mishap is handled by the people we know. We have also been able to come up with an organization for self-help called "Burial Party" to assist bereaved families in meeting burial arrangements. We all contribute to that course, being unanimously seen as need in our community. This way, we are slowly moving towards valuing sharing, and respecting each other.

The transition to the current relative calm is not without some harassment, coercion, arrests and even deaths of some of the local people in Tororo and elsewhere by the very government emissaries. Elder la Patan reveals:

> ...particularly when NRM had just come in. Some people who first got politicization came as cadres of the NRM and used these positions to intimidate, physically harass, and even arrest other people; often on personal or ideological differences but which they were able to report to central government organs as elements that posed a national security risk. We even lost a few people because of that practice by a few individuals. However, when it became apparent that we could vote such people out of office, we have been able to increasingly elect people who value and respect us, and whom we also entrust with representing us. We have slowly evolved to a relative state of peace. Now it is poverty killing us.

The NRM government's recognition of the role of women in leadership is not a new concept in the traditional social organization among the Osukuru peoples. While in some homes some men do mistreat and beat their wives, the elders shared their special pride on traditional positions of respect of women which has never been lost. Amu, an elder woman observed:

> I have always been organizing women and men in this clan's activities since my marriage here. In burial ceremonies for example, I have mobilized a lot of support from women and men alike. as a woman I feel I have made a contribution to this clan's well-being.

The rural people's view of *Kau* was evidently still strong in spite of all the social, economic and ecological transformations. That they would wish to see the youth, particularly those with formal education, imbibe this quality was evident in their body and voice projection. To these elders therefore, to appreciate *Kau* demands eschewing arrogance which is displayed by the so-called educated in high offices, and/ or the rich. They also had deep regard for simplicity, and an appreciation of the ways of *Kau* and all that is associated with its people. If there is a painful impact of formal education and industrial development in their locality, it would appear the way these have divorced an increasing number of people from respect and shunning of *Kau*.:

> *Mam kwa nu cut ebusakinit aiswamaun!*(This ought not to have happened!)
> (La Patan)

The centrality of these concerns to education is well expressed by an increasing number of philosophers and scholars in various fields (Toh, 1991; Brouwer and Carson, 1985; Hicks, 1988; Toh and Cawagas, 1987; Fien 1990; Reardon, 1988). In their commitment to a world of peace, these educators inspire needs to create a world of justice through informed communities with highly evolved conflict resolution skills, with values and attitudes for living in an interconnected and interdependent global village.

How does the concept of peace fit with science, technology, environment and development? In their illumination of the dimensions of peace education, (Toh, 1991) and Brouwer and Carson (1985) point out that peace education cannot be another discipline in the already crowded curricula at all levels. Rather, they recommend that it becomes the hub of every educational process and curriculum framework irrespective of the educational disciplinary orientation. In the vision of these scholars and other peace educators, all education is essentially peace education, with peace embracing more than an absence of war to capture aspects of social equity, ecological balance. These scholars also inform of the need for commitment to these concerns at the personal through community, national, regional and international dimensions of responsibility and accountability. Fien (1990: p. 34) makes a strong argument on social and ecological sensitivity, pointing out that "socially critical and politically responsive goals of educating for the planet need to be founded upon an over-arching framework of integration of values of holism that honor and identify with the whole movement of environmentalism". He sees the challenge of transformative education towards these goal education as one which interrogates the dominant profit-and consumer-oriented capitalist economic development and its models of education. Similarly, Hicks (1993) inspires educators to develop a more-future oriented perspective both in their lives and in the wider world, and to engage in active and responsible citizenship, in the local, national, and global communities on behalf of the present and future generations.

Taken in the context of the voices of participants in this study and of the cited scholars, the philosophy and mission of peace and environmental education in the formal educational set-up would therefore call for a re-evaluation of curricula goals, pedagogical approaches and materials, educational structures to foster participation and communication, respect, examination of issues of power, and needs for ecological responsibility and democratic ideals (Toh and Cawagas, 1990; Brouwer and Carson, 1985). In science discourse, subjects like physics have many possibilities of infusing peace education in its subject matter, like in the exploration of the interactions of science, technology and society. In this understanding, Brouwer (1992), a physicist, philosopher, and science educator, provides an informed and practical vision of reclaiming cultural framings of knowledge and living through a revisioning of some of the assumptions and practices of science and technology. Among the proponents of appropriate technology, non-violence captures modes of production which respect ecological principles and strive to work with nature instead of overriding natural systems in the conviction that unintended damage and unforeseen side-effects can always be patched up (McRobie, 1981; Schumacker, 1973).

Up-front therefore, the mission of peace education is congruent with the voices of the participants, particularly the rural elders of Osukuru, whose call is for mutual respect for people and nature on the basis of equity and identity. In the Ugandan perspective, peace education, modulated within the a holistic science, or ecoscience could a promising path to the development of social and ecological consciousness, and the reinforcement of indigenous identities of the majority peasantry in nations like Uganda. Such a goal for educational change would require an emphasis on the defense and rescue of the traditional peasant productive rationale as embedded in their culture.

7.6 Summary

This chapter has summarized views of university academics, students, professionals, and elders of a rural community in Uganda on how science and technology in education could be organized and engaged in alleviating problems for self-reliance within the cultural and ecological landscape of Ugandan society. The conceptions, arguments, and propositions for educational programs while all sympathetic to change, are presented as taking place within a variety of relatively conventional modern settings. There was a strong feeling and support among respondents for expanded educational programs to accommodate community participation, for more and/ or better teaching facilities which should be equitably distributed in all institutions, and for curricula that are inclusive of the range and diversity of contexts that accommodate participation. These calls revealed the marginality of moral and ethical concerns for people and the environment in the whole concept of education. A reciprocity of meaning between knowledge and participation that the participants urge for relates to Polanyi's sense of *Personal Knowledge* (1958), a process of knowing which reclaims a wider range of human perceptions, feelings and intellectual powers such that "it commits us passionately and far beyond our comprehension, to a vision of reality." (p. 64). The dominant and deliberate isolation of schooling from communities not only extols empiricism in the formal schooling curricula leading to a separation of object from subject and mind from body, but ostracizes and delegitimizes traditional values, isolating people from their ecological, emotional and cultural contexts.

In the perspective of participants, this limitation in the contemporary framework of education is embedded within its structuring of knowledge on the basis of disciplines. While this has had an advantage of being an efficient means for delivering knowledge, it was seen as having taken on a competitive edge which has tended to commodify knowledge and turn learners into clients and customers. Such framings of science in education has made scientific concepts and skills to be seen as realizable only in special places like schools, colleges, universities, and in classrooms and laboratories. From the ideas and experiences raised by participants, it is apparent that students and educators at various levels of education hold this understanding. They are thus deeply preoccupied with scoring high grades in academic examinations. Pedagogical practice of exam-centered discourse distorts field-trip experiences to communities or to ecological settings to simplistic goals of getting facts rather than of seeking deep-rooted understandings with transformative intentions. This practice has made educational discourse reductionist and contributing to the enhancement of the separation of learners from the real world of work and the setting from which they are socially, culturally, and spatially associated. To the participants, this functional separation of communities from formal education as a setting for discourse automatically denied the emergence and immersion of science and technology in the human condition and meaning. In particular, there was acknowledgment of the need for scientists in Makerere and the school system to work towards establishing a dynamic integration of aspects of indigenous knowledge into science, and to encourage and support development of ecologically sensitive appropriate technologies.

In the curriculum, issues related to cultural concerns in science, technology, and environmental care which should be addressed in the surroundings with communities' analysis, assisted by students and teachers, were seen as excluded from the current model.

University academics who participated in the study showed legitimate interest in disciplinary and institutional boundary crossings in the teaching and research in science. But lack of institutional acknowledgment, rewards, and funding for these collaborative engagements among departments and corresponding programs were identified as constraints. The implied requirement was a comprehensive government policy on education, science, technology, environment and development that had frameworks and provisions to accommodate these innovative changes. Recognition and promotion of women in science and technology and in education in general was strongly supported with a call for a value orientation in curricula to engender attitudes of empathy, servitude to communities and their lived realities. There was also a unanimous view among participants for a closer dialogue among politicians, educators, and other professionals and leaders to harmonize national planning priorities with the majorities' condition based on equity, justice, and ecological balance.

CHAPTER EIGHT

SUMMARY AND CONCLUSIONS

Uganda as a nation has a strong policy in support of science and technology and their role in development. To attain its goals of modernizing the economy, the Government in its White Paper (1992) on Education made firm recommendations for education to promote science and technology programs with a view to enhancing rapid capacities for the exploitation of natural resources and material wealth creation. Because of the potential modern science has in shaping people's lives and the environment, this study explored sociocultural premises that could underlie and sketch ecologically sustainable and socially just ways of organizing and acting in people. Within the interactions that ensued, the interest was to identify possible ways in which science and science education become media and sources of empowerment. This required the study to seek out what professional beliefs, assumptions and practices could encourage and contribute to socially critical objectives that underpin environmentally conscious development activities in Uganda.

The relevance of the dominant strands of western-derived science and technology education in Uganda was explored through discussions based on interviews, focus group meetings, and a workshop held with elders of a rural community in Tororo District of Uganda, university academics, some students of Makerere, as well as some officials in government departments of education and environment.

This chapter is a summary of the major findings and conclusions based on the views of this range of participants, and a critical analysis of documentary data that related to the question of the ways in which science and technology in education coupled with indigenous knowledge could contribute to Ugandan development theory and practice based on principles of sustainability and sociocultural justice. Recommendations are also drawn from the findings and are hoped to spur interest in transformation of the role, programming, and discourse of science and science education at Makerere University, the school system and policy frameworks that relate to science and technology education in Uganda. The Chapter concludes with some implications for further research.

8.1 Summary of Findings

Inadequacy of Current Development Paradigms. The colonial past of African emergent states was acknowledged by participants as a significant influence on post-independence economic, environmental, and sociocultural frameworks among nations in the South such as Uganda. The most significant of these impacts was seen as arising from a belief and commitment to economic development which employs modern scientific and technological exploitation of ecological systems. This level of advocacy was noted by the participants as having legitimized the strong belief in economic growth through industrialization based on modern science and technology. The implications of this for African states that are now independent but interdependently linked to former colonial powers and allies is the transfer of specific forms of technology especially the pursuit of scientific advances through education. The supremacy of the former colonial masters and their allies among the industrialized nations and financial institutions like the World Bank and the IMF were claimed by some participants as continuing to maintain a high level of influence and control among the developing nations and through loans and grants. There was a major concern among some participants that external influence to national affairs is manifested through the agenda of some donor agencies that promote dependence economically and in many aspects of education, including science and technology.

With science and technology increasingly becoming the primary means by which humans interact with each other and with the earth, their use was seen by participants as requiring the determination and experiencing of ways that are socially, culturally and ecologically centered. Serious effects on the people and the environment arising from pollution by industry and other applications of science like the use of fertilizer were pointed out by the participants as being on the rise in various parts of the country. The large and rapidly growing volume of scientific and technological knowledge were also pointed out by the elders and some other participants as presenting problems of assimilation, integration, and access. Greatest among these effects of science and technology transfer from North to South was, according to participants, the delegitimization of indigenous knowledge and practice in areas such as medicine, nutrition, indigenous technology, and indigenous resource management wisdom which encompasses aspects of spiritual respect for various ecological features. As Iannone (1987) and Goerge (1987) argue, the growing holistic movement in North nations both within and outside the medical profession is symptomatic of some of these changes in emphasis, technique, and policy. To the participants, the potential to respond to scientific and technological changes could be greatly curtailed due to high indebtedness to the World Bank, the IMF, and commercial banks in industrialized nations. This is aggravated by the application of structural adjustment programs which aggravate the poverty and marginalization of the poor masses in South nations like Uganda. In a similar tone, the participants argued that the costly transfer of science and technology to the developing nations has its problems which have been ignored, for example the interactions between science, technology, environment and sociocultural groups. The rural elders were critical about the introduction of the cement and asbestos factories which led to massive cutting of trees for firing some of the ovens with no remedial aforestation programs by the industries nor by government. They also lamented the pollution caused by the corrosive dust and gases that depleted their ecosystem, and affected the health of many people. The other example shared by the elders on imported science and technology related to products like DDT which was distributed to boost cash crop production for export without offering with no serious advisory to the communities about its harmful effects to this day. They pointed out that through appropriate policies and education opportunities to increase awareness about the incompatibility of economic and environmental concerns could be brought to the center stage to debate goals of development within the context of sociocultural and environmental balance.

The changes in the lives of indigenous peoples in many places in the world give rise to serious re-adaptations to new conditions. Arguing that indigenous peoples represent many peoples, cultures, and different ways of thinking which are now under threat by modernization, a regional Environment Workshop (1979) made strong recommendations for alternative models of development. In particular the workshop called on industrial states not to compete with tribal groups for their resources, emphasizing that indigenous resources must be used only with clear consent of affected groups. Ties between local elite leadership and international institutions were also identified and seen to be stifling representativeness and responsiveness of policies to the needs of the majority and the environment. Governments of the developing nations are, in the opinion of participants, saddled with overgrown and corrupt bureaucracies attempting to control all aspects of rural people's development, including their relationships with the ecological systems around them. In the view of the Osukuru elders and other participants, population pressures and poverty have intensified deforestation caused by overgrazing or the need for more arable land and firewood. These were seen to have led to desertification, soil erosion, flooding, and micro-climatic changes. Malnutrition, disease, lack of clean water and proper sanitation weaken the poor, making it difficult for them to break the vicious circle of poverty which affects mostly women and children.

Policy structures that promote and support these normative participation and interventions of international agencies were seen as suppressing formulation of an internal agenda that could innovatively address the genuine problems of worsening poverty among people and in the natural environment. Poorly articulated development policies both in development and education, coupled with hierarchical administrative mechanisms, were identified by participants as prohibiting the realization of growth or development as a process involving the participation of the majorities. So while aid to national development strategies in poor nations in Africa has supported some important and essential programs like healthcare, albeit for the benefit of a privileged few, for the participants, such programs have often ignored the degradation of the environment and perpetuation of structural inequalities inflicted by modernization.

This notwithstanding, participants noted that the input into the research the majorities marginalized by such scientific and technological pursuits is lacking. This, to them, has preempted donor institutions or organizations to hire experts from abroad to propose and implement various development plans within the modernization framework which continues to undermine the local needs of the majorities. In science and technology, such a scenario was seen as ensuring the continued dependence of Ugandans on North-based structures and inputs of science and technology, and never towards evolving locally useful and sustainable forms of science and technology. Unable to formulate internally motivated and meaningful science and technology agenda, a university like Makerere was seen as a vehicle for upholding social inequalities and ecological crisis in its promotion of worldviews, research agenda, and knowledge validation that are categorically remote from the contextual needs of the majorities in the country. Clearly this has implications on national policy in shaping and defining how people interact with the natural environment.

The insensitivity of politicians, particularly in the past governments of Uganda, towards the defense and rescue of the traditional peasant bases of production, culture and identity was, from the point of view of the participants, partly a direct reflection of the nature of education that has socialized politicians and others occupying privileged positions to be indifferent to the plight of the majorities and of the ecosystem. The philosophy, attitude and approach to such educational curriculum and structure were noted by participants as being responsible for keeping South nations like Uganda from evolving endogenous priorities of education. Accordingly, participants argued, scientists educated through the curriculum have largely failed to appreciate both relevant understanding of scientific knowledge as well as an understanding of the system to which it should be applied. Rather, to engineer the shift from traditional to modern competitive society, Uganda needed appropriate policies for integrating and applying modern and indigenous science and technology in all sectors including industry, agriculture, and even social sciences. Such policies, in the view of participants, could ameliorate the social, economic, cultural and ecological consequences that have so have undermined the quality of life of the poor majorities and the sustainability of ecosystems.

The persistence of poverty in Uganda amidst continuing environmental degradation, and the belief that modernization will be the savior, was criticized by participants. They saw the need for a comprehensive alternative understanding of the African condition in general, including the complex interrelationships between domestic aid, education, science, technology, environment and development.

The Sociocultural and Environmental Responsibility of Science. As part of the rural masses for whom national effort in education and development should be focused, the views of a rural community of Osukuru in Tororo District of Uganda were valued and included in this study. The indigenous rural elders of Osukuru reflected an overwhelming connectedness to natural systems based on their traditional beliefs. The natural systems like rocks, mountains, rivers, forests and the soil or land were regarded by the Osukuru elders in their cultural codings as having custody of specific powers of protection and of their own being. Based on these interpretations of natural systems, these elders of Osukuru, both men and women, expressed dismay over the collapse of ecosystems in their locality due to deforestation, drainage of swamps, waste disposal and sanitation problems, and unabated pollution from industrial emissions, solid waste and effluents, about which they had no skills nor knowledge capabilities to reverse.

The university academics acknowledged that science has a great potential to provide wider options for people to better handle environmental and other technical problems in the country. It was also noted, however, that policy and practice in science and technology in Ugandan educational institutions, relegated this potential to the margins of things vis a vis problems of increasing poverty, alienation, and environmental crisis epitomized in Tororo and other parts of the country. These powerless voices of the rural people are not usually sought and/ or considered in scientific, technological, developmental, or educational discourse. Rather, they are viewed as anecdotal, unempirical, amethodical and unpragmatic and hence backward and "non-developmental." Yet to this rural community, an economy based on simplicity and reciprocity with nature, the whole concept of collaboration constructed under frameworks of love, interdependence, respect and commitment characteristic of their indigenous socialization is now grossly undermined and distorted by the competitive market oriented activities. In providing an empathetic response to elders' voices that clearly value working and living together under an umbrella of cultural identity and a healthy natural environment, there is a great need for an elaborate concept of justice and fairness in the role of all aspects of education, and its responsibility as an agent for national development and unity (Odaet, 1993). Crucial for consideration is the need to listen to more of these voices, and to take into account the mortgaging of people's system of values, aspirations, linkages among themselves and to nature.

The aggressive pursuit by Uganda for economic growth, industrialization, and increased agricultural productivity in all sectors is matched with a call for the expanded and popularized teaching of science and technology in institutions of learning. This would make it appear that the aforesaid pursuits are a responsibility which is profoundly anchored in educational settings, thus providing educators with an opportunity to influence the direction of science teaching and applications.

Calls by the Uganda government for Ugandans to pursue science and technology education is to emphasize the role of science in creating the engines of economics both domestically and internationally. This makes science not just an approach to knowledge or a body of knowledge in the fragile sense as fields of history and literature are. Science is, in addition, acknowledged as something that can work for people. It has been used in the discovery of penicillin to the manufacture of atom bomb. The dynamism of science in working for people would, however, appear to be constrained by some contradictions. Among these was an observation made by a science professor who expressed an overwhelming belief that science cannot be reduced to or conjugated with politics, nor to arbitrary power as opposed to rational knowledge. Traditionally, scientists appear to have been shielded from direct involvement in social and ethical controversies concerning the implications of their work. Some scholars like Iannone (1987); Nelkin, (1987) and Haraway (1991) explain the observable low participation of scientists in public discourse related to science and its social uses and/ or implications as due to previously long time lags between applications of science and its effects. In the current times where there is almost instantaneous application and impact (positive or negative) of new science or technology, these authors argue that the luxury of neutrality between science and political discourse is no longer an option. From some participants in this study, there were acknowledgments that such a public accountability is part of the professional duties of a scientist. What was apparent was a lack of political will or inability to value scientific input to political and/ or policy matters that had scientific and technological solutions. The appeal of the elders and other participants should provide a strong invitation for concerned Ugandans to perceive more clearly the contextual tensions between science and society and the presuppositions of development that are informed by science and technology.

The elders also raised concern about the extent to which elements of their traditional (indigenous) knowledge system and their culture have become dysfunctional, particularly among the youth who are increasingly attracted to modernization provided by science and its technological ramifications. These voices should draw the attention of scientists and science educators to the nature of legitimacy which a scientist needs to have in a traditional society whose paradigm for change may be different from the dominant modernization perspective. The elders' narratives could also act as guidelines to alternative frameworks through which cultural, social and ecological realities could become the anchors for scientific imagination and creativity. These indigenous sensitivities to the ecological balance, now manifested as fear for people's estrangement from nature due to modernization, gain a lot of support from contributions by Ilya Prigogine (1984) and Holling (1984) on humanity's dialogue with nature. In their writings, Prigogine and Holling critique the ways in which modern science and technology have increasingly impacted and created chaos in the rich and complex order of natural systems. As the Ugandan elders and indigenous peoples worldwide likewise have reiterated, wisdom and spirituality have enabled them to live in relative sustainable harmony with their natural environment for generations.

In the understanding of most of the participants, the promotion of science and technology in education by government planners as a means for advancing Uganda scientifically and technologically has not met with an equal commitment by institutions of learning to evolve a science responsive to local basic needs. In particular, accounts of the rural elders suggest that the great majority of graduates of science do not live up to the expected functional scientific literacy in handling problems that are solvable by science. To the participants therefore, the challenges of science and technology in education in Uganda, and their contribution to national development should manifest in a number of interconnected areas. First, science and technology education needs to relate to indigenous knowledge and harmonize epistemology of science with local context and world view. Secondly, policy makers, educators and researchers need to gain a critical understanding of the impact of the framings of science, technology and society within the stipulations of development. Thirdly, it is vital to establish links of solidarity between scientists, educators, government officials, and the wider international fraternity in harmonizing development, the role of science and technology, environmental care, and the interests of the poor in the South. Such an understanding was seen as requiring both education and political will.

The first of these challenges as echoed by the participants is the issue of the foundations upon which science and technology, in knowledge and practice, are based in Uganda. Having been a protectorate and colony of Britain, such a colonial history and experience deeply penetrated the fabric of the education system, uprooting the traditional system of knowledge and education. As Goldthorpe (1965) and the Visitation Committee (1970) have both convincingly pointed out, the curricula in Makerere University and the other levels of education in Uganda closely resemble those found in more conservative parts of the British educational system in content, examination and grading. Until the late 1960s and well after independence, Ugandan students were still assessed by the overseas examining boards bound to the Eurocentric orthodoxies of content selection and standards of achievement.

It was also a general understanding among participants that science programs at university and school setting are predominantly academic, descriptive, knowledge-based as in grammar-school traditions in the United Kingdom. Established by a colonial elite whose rationale was to ensure that their children had access to similar education as in the United Kingdom, schooling for the Ugandan children meant losing touch with their cultural identities and sense of reality. For Uganda, this has meant that the expert scientists and the technological innovations they can muster are coached within modern science and technology perspectives, whose interests continue to transform the natural environment in the bid for ever higher levels of economic growth. The second and third challenges of science and technology in education are discussed in the subsequent three sections under science and technology policy, human resource development, and pedagogical issues.

Science and Technology Policy An understanding of clear directions and the role of science and technology in national development has significant implications to national science policy. It was evident from the discussions with prominent science academics at Makerere that science education has not deemed science and technology policy making under the modernization paradigm to be problematic.

Science academics at Makerere university tended to consider policy issues as a matter for government alone, and in the university setting, policy studies are considered a responsibility of the social sciences and humanities. Yet if science education is about development of human resourcefulness for balanced living and not simply an academic and professional excursion, the centrality of ascertaining its goals based on appropriately formulated policy is clearly a priority in science faculties also.

Resonant with Lewin's (1989) argument, many participants saw that pursuit of western based science by a poor nation like Uganda was tantamount to casting the problem of development simply as that of transfer of science and technology. Such a perspective of science and technology in development could be responsible for the general belief and drive to follow the footsteps of the "successful" North, as well as the anxiety of science academics to maintain similar research and teaching topics as in the universities in the industrialized nations. For Uganda therefore, this optimism in the pursuit of western science has continued to reinforce the belief that science and technology are universal and can be simply transplanted with an unquestioned assumption of its viability under local social, cultural and ecological environments.

Some participants argued for the creation and adaptation of scientific and technological knowledge for local application. This recommendation was a call for a science and technology education, supported by appropriate policies, to replace direct science and technology transfer with a judicious mix of appropriate and indigenously developed science and technology which are directly based on the needs of the majorities. This desire for the revisioning of science and technology places a demand on the need to understand the very philosophical and historical underpinnings of modern science and how these have been shaped by various social and economic interests. An example that featured in this study relates to how the problems of development have tended to be shaped more by international than local forces rather than the other way round. Similarly, some participants agreed with the position of renowned philosophers like Kuhn (1970) who find extremely problematic the view that science is universal – seeking knowledge which is independent of social or cultural milieus. The concern raised by participants who challenge a positivistic view of science is the tendency of scientists to abdicate responsibility for some end-uses and impacts of scientific knowledge. Many parts of the world, faced today with varied challenges of social, economic, and environmental changes accruing from scientific knowledge utilization might benefit from an understanding strongly raised by a physicist and philosopher, Brouwer (1994), that the utility of scientific applications (technology) needs to be informed by needs, safety and specificity of context. Brouwer's concerns echo the fears of the participants, particularly the elders of Osukuru community, that industrial development in their midst has caused serious damage to the environment, as well as socially alienated the youth from the indigenous ways of life. The participants' reflections on this theme further exposed the incalculable risks that people are exposed to in the massive environmental transformations occurring everywhere as a result of industrialization and economic modernization.

This also goes to show how the tendency to see and perpetuate science as a body of "pure" "objective" knowledge, untainted by human emotions and values, can hand over entire communities as hostages in the unquestioned assumption that people will increasingly be able to control social and environmental change through public policies that promote modern science and technology. However, some participants argued that the very nature of the capitalist economy founded on a complex industrial technology may prevent effective control of public policy due to greater international and/ or corporate interests.

Poor nations like Uganda with limited access to international markets have hardly any resources to compete globally in most fields. To the participants, therefore, emphasis in science and technology should be on the needs of the population with special provisions for advanced modern science and technology only in carefully selected areas. These could be vantage points for scientists to employ individual creativity in exploring meaningful links between sociocultural and ecological needs. The ethical concerns about science and technology relate to the fact that advances in science and technology sometimes blur ethical boundaries that previously (at least in the cultural context) had a high valuation of nature, respect for natural and social limitations of growth, a sense of empathy with other species, other people and the future generations, and support for careful planning in order to minimize threats to nature and the quality of life. In the industrialized and in some developing nations, some analysts like Barbour (1993) reveal that more and more scientific and biotechnological research is increasingly relying (necessarily or unnecessarily) on humans and animals for experimentation and theory validation. These concerns raise the urgent need to develop satisfactory ethical guidelines and controls, because science and technology can no longer be regarded as ethically neutral or value-free.

Various participants' concerns over the ecological impacts of industrial and other commercial exploitation of natural resources. I note an emergence of an awareness that modern scientific and technological education, research and development have interests that have ethical and moral problems. Perhaps in ways earlier generations did not encounter, there is also an increasing knowledge and lived experiences among Ugandans as elsewhere that what is called "pure" science or "innocent" knowledge can easily have significant, sometimes harmful, societal and environmental impacts when unquestioningly pursued in the name of economic "development". The implications of this for planning science and technology education at policy level require an evolution of a clear understanding of the role science and technology play in national development strategies in ways that consider social and ecological balance. As was pointed out earlier, these considerations place a demand or need to have science and technology to embrace moral and ethical dimensions, as well as the cultural and historical rootedness of people's experiences in their processes.

Science and Technology Education and Human Resource Needs In its recommendations, the White Paper (1992) on Education Review in Uganda places emphasis on quantitative shortages of science and technology literate cadres to overcome human resource limitations that are, by implication, thought to obstruct development. These stipulations do not specifically target areas of science and technology on which emphasis should be placed. While this study has not specifically addressed the impact of science and technology in education on human resource needs, some aspects related to this theme somehow emerged amidst the study's discussions. Among a number of participants there was a strong feeling for Uganda to plan science education to serve its national and local needs.

According to the participants, emphasis on grades, with the distortions associated with the "diploma disease" and paper qualifications, have taken a heavy toll on the pattern of teaching and learning. The quantification of teaching and learning outcomes in terms of grades and graduate numbers was challenged by professionals interviewed during the study. To these professionals, the emphasis on grades and passing will reinforce narrowness of the curriculum to examinable knowledge at the expense of exploration, understanding, practical skills, interest and motivation of how science and technology/ is or can be culturally grounded in local and ecological needs. The concern raised among participants is derived from the taken-for-granted assumption in the Uganda government's planning that more science and technology teaching will automatically translate into needed development surplus. The central critique was that science as it is currently taught only equips school leavers for the next level of education rather than for the felt and lived realities of the Ugandan society.

The Role of Women. It is fairly conclusive that such a background of curriculum formulation in Uganda also ensured how science is defined, conditions under which it can be done or taught. Crucial in the concerns for participation is the world-wide concern for the depreciated role of women in science and technology. As accounts of some participants and discussions by authors like Mulemwa (1993) reveal, Uganda is no exception. One university student described her personal experience of coercion by a male staff to discourage her pursuit of a graduate degree in science simply over her being female. Such experiences elucidate the limitations imposed upon the role of women in science and technology. Such pedagogical climate was noted as having excluded greater numbers of the female folk from science and technology based careers.

The claim that science and technology were value-neutral could have served to render invisible the injustices in the system by sealing an already self-reinforcing gendered structure. For the few who have achieved prominence in these fields, they have been considered atypical of their sex. Insights from this study's female participation show greater interest and concern among the female folk themselves to assume a greater role in education, and in science and technology in particular. This may accord women greater participation in these areas. A revamped educational system and curriculum in light of these perspectives was pointed as a way to empower women by giving them greater participation on most aspects of life that affect them and children. More women in science and technology would also promote development and use of appropriate technologies for women in the African settings, making their tasks less burdensome and more productive.

Towards an Ecoscience: A Framework. This concept of science is drawn from both the perspective of the elders plus other participants, and an understanding that science and its appropriate technological ramifications are useful for meeting human basic needs like food production and storage, shelter, energy, transportation, health care and clothing. In sharp contrast to the ways modern science is being applied, ecoscience envisages a science discourse which, in light of the voices of the elders in this study, envisions a society based on sustainable-earth and people ethics. An ecoscience framed by sustainable-earth ethic is participatory and non-competitive in discourse. It is based on the belief that science and technology should be used to keep humanity as an integral part of nature, and as the elders exhorted, our primary purpose is to share not to plunder the earth's finite resources; and that humans should interfere with nonhuman (animate and inanimate) parts of creation only to satisfy basic needs, and work with - not against nature. To most of the participants including elders, there was an awareness that matter and energy resources are finite and must not be wasted, and used to selfishly benefit the dominant few.

An ecoscience will therefore reject the primacy of the economic criteria of ever-increasing production and consumption in the framing of policies is currently reflected. Ecoscience will also have strong reservations on unlimited industrial expansion in favor of productions which work with nature and people. The discourse of ecoscience will advocate selective modifications of small parts of the biosphere to meet human needs on the basis of ecological understanding and caring for the earth and all its species and physical stature. The applications of ecoscience will therefore relate to making people's lives more harmonious with natural cycles. It would urge for adopting a philosophy of *Voluntary Simplicity* based on doing more for less. The discourse of ecoscience will not identify with the current sociopolitical framework which, the participants noted, reflects short-term and short-sighted planning and goals. Instead, as participants argued, it must support the construction of new understanding which bases society's, and individual's decisions including those of women on long term planning, and goals, processes and activities embedded within an ecological intuition. This ethic is equally embodied in the concepts of Deep Ecology (Naess, 1989); Elgin's (1982) view of Voluntary Simplicity, Fien's (1993) vision of Education for Sustainable Living, and many other insights from scholars committed to educating and for peace and justice.

Great hope lies in getting more countries in the South and elsewhere to consider the merits of a more ecological, more holistic approach to science and technology under the framings of such an *ecoscience*. More ecologically responsive education for men and women in general elevates our capacity to conserve the environment because in Africa, most people, women in particular, have a greater contact with nature related activities

(McRobie, 1981). Equally of benefit would be better stabilization of population, reduction in child mortality rates, better agriculture, nutrition, and resource management based on sustainability, with more women and men with a caring ethic who are empowered ecologically, socially and intellectually.

Pedagogical Issues Study participants were also very interested in seeing science discourse embrace qualities of teaching and research which foster cultural values, engage the great wealth of indigenous knowledge in the country, and encourage greater participation of various groups like women and rural communities.

In Makerere University, science programs promote an elite, pure science bias with pedagogical approaches dominated by the lecture method with limited or no student-centered approaches like seminars, workshops which seek to establish creativity and academic independence of students. Among the effects such technical, ends-means pedagogy is what Jacknicke and Rowell (1988) have pointed out as a presentation of science in an ahistorical way which denies development of deeper understandings of the meanings students place on events and happenings which shape their existence.

An overwhelming view of the participants was that science and technology programs need to evolve in Makerere University and at other levels of education in forms that resonate with the local cultures and aspirations and sensitivity. This suggestion came with the anticipation that science and technology taught with equitable benefits to society, the life of students and the natural environment as an end could allow elements of tradition to become functional for the growth of science. The caveat noted, however, was that as a poor nation with a growing foreign debt with one of the lowest per capita incomes in the world (Brown, 1995), Uganda may have a long way to go in coming up with representing science in ways that are not foreign and expert directed and in formats that are culturally and ecologically coded. This notwithstanding, the students, professionals, and some university academics consulted during the study advocated new approaches to university teaching of science which rise above the commonality of scientific methods and arbitrariness of science-subjects divisions. As Norgaard (1994) argues, an urgency for a shift to holistic framings should take heed from the complexity of the changes now occurring in the real world problems which demand the multidisciplinary nature of inquiries, dissemination and action.

Some participants were mindful of conservative forces and bureaucracies in both Makerere University and government who they feared may be hard to convince towards such changes. For science as well as science education, the implication for no transformation is to maintain the status quo of disciplinary science and science education.

In science teacher education, this would imply that programs remain tied to a single subject agenda, hence reproducing resistance to multidisciplinary innovation, much against transformations in other universities in which there is increasing acknowledgment of interdisciplinary approaches to environmental science and education (Braddock, Fien, & Rickson, 1994). A number of participants believed that science and technology should become part of the core subject curriculum in university science. The concepts and frameworks of technology, Society and Environment in a science curriculum present an area for further exploration to identify the most appropriate degrees of their relative inclusions in various science disciplines. The contemporary view among most university participants regarded science as practically independent of all aspects of technology in both theory and practice. In whatever direction the disciplinary versus multidisciplinary debate rests, the current curricula orientation of science in both Makerere University and the school system is a disciplinary model. According to the educators who participated in this study, the interest to include communities' participation and indigenous knowledge which is more holistic and often practical in nature, alongside interests to give science wider scope to respond to social and ecological problems put a demand that goals of science and science education at Makerere University need to change. This, they noted, will also demand that such curriculum reform in science makes a significant shift from nature and structure of science and of factual teaching of the *discipline* ideas in science towards wider emphasis of the contribution of scientific knowledge, in concert with local knowledge, to the amelioration of human, social and ecological problems.

From the voices in the study, I note the presence of some barriers to such change even as humanity enters the twenty-first century with all its contradictions between modernization, ecocrisis, poverty, marginalization of some groups, all of which clearly auger a need for change to plurality. What was apparent to some study participants was that the current technocratic conception of science and structuring of the science curriculum and teaching, and research projects have also assured science an elite preserve of alien knowledge, the practical value of which has not come close to the experience, participation, and basic needs of most of the grassroots populations. Any achievements in science education to speak of in Uganda were pointed by most participants as dictated by the orthodoxy of science into the narrow conduits of disciplines of Physics, Chemistry, Biology, Zoology, Botany, Geology, Biochemistry and Mathematics. This straight-jacketed approach of scientific literacy is witnessed in this study as having over specialized Ugandan scientists and science-based professionals more on theoretical and descriptive depictions than on problem-solving capacities of scientific discourse. In the expressed view of participants, this was seen as enhanced by two factors. First, that no attempt has been made to relate technology to each aspect of science, with the dominant view being that technology is separate from science. Second, the scope of societal knowledge of traditional concepts and descriptions of phenomena and problems covered in science is nonexistent in Makerere University and school science settings.

Meyer (1977) makes a strong recommendation that the break away from disciplinary, didactic discourse in science would be the sure way to effect a synthesis of content, process and values which will also bring about the confluence of understandings, attitudes, skills, and insights to resolve conflicts between values. In a similar vein, Thomas Jefferson makes the following assertion:

> I know no safe depository of the ultimate power of the society but the people themselves; and if we think them not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it from them, but to inform their description by education. (Quoted in Alberta Education, 1990; p. 31)

This conforms with the thinking of the participants who believe in the value of educational linkages with indigenous knowledge. With such an omission the graduates of science and science education programs at Makerere are potentially denied the capacity of being equipped with what Popowich (1984) advocates, namely, a measure of scientific and technological literacy for meaningful life in a continually evolving society and environmental changes.

At the secondary school level, there was no ambiguity that science is a universal process of inquiry on natural phenomena and that its teaching should engender these qualities among students to equip them with capacities for furthering science and harnessing its theories towards improving human conditions. While legitimate objectives, most of these goals for science were perceived by some participants as lacking internal continuity in the Ugandan context. In the experience of the science specialist at the Ministry of Education/Curriculum Development Center alongside that of other educators, the school curriculum innovations in Uganda have largely depended on ideas developed elsewhere, citing the Nuffield Science Program of the 1960s and the School Science Project (SSP) of the 1970s as examples. The downside of this reality is that the enthusiastically adopted fashion of science is not motivated by the degree to which it fits with local resources, teaching and learning needs, and sociocultural norms. The SSP program for example, could not be sustained locally due to its unmanageable demand for materials and equipment and was dropped in schools in mid-1970s after only several years' operation. While the adapted science curricula have definitely made some useful contribution to Uganda in developing its current capacities in various sectors, Olupot (1995) complements the concerns raised here in his observations that such adoptions and modifications of curriculum changes have served the interests of the local bureaucracies and elite groups more than the majorities. The high school science teachers were unanimous on the point that the school science curriculum, like that of Makerere University, was examination and hence elite-centered. The teachers informed that environmental education was extra-curricula, and when taught, it was for purposes of getting students to memorize scientific facts related to sanitation, erosion, deforestation and pollution, and not to the surrounding issues like poverty, problems of modernization and the whole support structure of economy and its injustices. So the technical rationality in a positivist science discourse in Makerere University is similarly represented in schools, potentially promoting the contradictions which may be involved even in the very cherished scientific approaches such as inquiry, questioning, challenging traditional beliefs, and the unbridled authority in the physical and natural world of experimentation and hypothesis testing, by overshadowing realities of learners who hail from communities where none of such approaches is the normal conduct of affairs. I remember an event in my teaching in a girls high school in Uganda in 1988 where a student fainted on her first dissection lesson because, as she later explained, it is taboo in her clan for a woman to kill a frog. The insensitivity of the teacher was, however, the greatest disappointment because the student was with indifference advised to "frog-jump", a phrase meant to ask her to avoid frogs, and it became her nickname in the school. Much as I sympathized with the student, I, nor the school administration did not take any steps to counsel the student nor the teacher on this incident. The science teachers also acknowledged a lack of committed efforts in schools to relate science to real life situations and needs. This was pointed out as partly arising from poor contact with communities, partly generated by rigid programs in the school time tables which had no provision for out of classroom field experiences, except on special arrangement with school administration. Funding and poor conditions of service teachers, like at Makerere university, was pointed out as a serious constraints which allowed no spare time for teachers to devote their extra time to innovate on teaching.

8.2 Recommendations for Science and Technology Education

The range of findings and conclusions from this study suggest some recommendations for science and technology education in Uganda. It is hoped that these recommendations will provide insights for dialogue among policy makers, educators and researchers to work for the cause of the environment and marginalized majorities through socially and ecologically informed views. These are hoped to shape and guide sensitive framings in support of an ecoscience with related appropriate technologies.

A Context for Science in Uganda Universities. Science programs have clearly tended to portray the various aspects of science like Physics, Chemistry, Biology mainly as purely theoretical intellectual explorations of nature in its various representations. The emphasis, organization and teaching of science programs at Makerere University as disciplines has tended to constrain the learning goals to knowing the structure and basic principles of each discipline. The goals of learning activities are designed to equip students with the vocabulary, language, mathematical and observational skills for scientific exploration, data collection, analysis and communication.

As Hurd (1994) has observed, this vision has downplayed some vital dimensions of science. He specifically identifies technology as an integral component which, when omitted would tend to overshadow alternative framings and goals of science. The concern to pursue science for the common good and fostering the welfare of the natural ecosystems and of the local communities in Southern contexts would call for curricular goals that focus on developing an understanding of the natural world with an aim of acquiring intellectual, and practical skills for living and participating in both the indigenous as well as 'scientific' culture that may need to balance its structure with a judicious mix of technology. This as a goal for science and technology in education for the future, makes scientific literacy a process of enculturation - a goal that should be championed by university education. The debates by participants in this study on this issue crystallize what Hurd (1992) identifies as an educational vision that brings science, technology, and society into a common package of knowledge generation, dissemination, and application.

In light of the reflections we have encountered from different participants and theoretical analysis from other scholars, Uganda requires a science education which raises questions about, and seeks a practice of freedom, not the transfer or transmission of scientific knowledge, technology, or of cultures. Nor should such science education be an extension of technical knowledge or an attempt to adapt the educatee to the milieu (Freire 1970; 1974; Macedo, 1993). To Freire and other critical pedagogy advocates, education as the practice of freedom as opposed to education as a practice of domination denies that humanity is abstract, isolated, independent and unattached to the world - the natural environment - from which sustenance is derived. Rather, a truly liberating and holistic education denies that the world (environment, culture, indigenous knowledge) exists as a reality apart from humanity.

Such a view of education, particularly in relation to environmental literacy, should be a problem-posing education in which humanity develop power to perceive critically the way we exist in the environment with which and in which we find themselves. Such a science education should provide the learners with a dialogical interpretation of the environment not as a static reality, but as a reality in process, in transformation by their agency (Fien, 1990; Huckle, 1988). In the perspective of this study, a science that captures sociocultural perspectives and ecological awareness fits in with the framings of Freire's liberating education. It is such a framework of science whose discourse will bring about holistic understanding of the value-complexity of problems of using science and technology and of living and acting in the environment with a view to ensuring sustainability. The perspective of sustainability here captures what Elgin (1993: p. 13) notes as follows:

> To be sustainable, a civilization must maintain the integrity of the physical, social, and spiritual foundations upon which it is established. To seek only to survive - to do more than simply exist - is not a sufficient foundation for long-term sustainability. To engage our enthusiasm for evolution, we look beyond sheer survival - we need a compelling sense of purpose and potential for living together ...

This calls for developing environmental and sociocultural awareness focusing on discussion-based inquiries which extend beyond the school system into the community in acknowledgment of the right to equal participation. These provide the opportunity for schools and community to collaboratively participate in, and make informed judgments and decisions about, environmental action and ecosensitive development patterns.

Making science more responsive to people's needs and sensitive to ecological balance ties closely with multicultural perspectives of science education. Multicultural science education advocates like Hodson (1993) have demanded for a shift towards ethnic and cultural pluralism as a means of accepting and promoting diversity. Behind this call is the intention that the dominant minority should learn to appreciate, understand, and value the different conventions and cultural norms of other and smaller (often marginalized) groups and citizens. Matthews and Smith (1994) extend this shift as serving antiracist education concerns, by flushing out the ways society is organized, the values on which it is based, and the ways in which power is exercised and restricted. The pedagogical and research implications of Hodson's view of multicultural science education, equally echoed among the study participants, places an emphasis on addressing real-life situations, relating science to wider and societal, technological, and, in this study, ecological issues. Hodson also argues for "development of scientific literacy in the context of active and responsible citizenship, ...ensuring science as more person oriented; starting from and building on children's existing knowledge and experience; using problem solving activities to develop creativity and promote decision-making and social skills; and, enhancing each student's self-image and self-worth" (p. 685). Alternative scientists like Capra (1982), and Suzuki (1989; 1994) have strongly catalyzed and infused scientific and technological theory and practice with wisdoms of nonwestern or indigenous peoples and traditions. So the shift in science perspective captures the critical dimension of issues of justice, freedom, and equity and of responsibility and accountability. By illuminating the ways in which science and technology are culturally determined, science education can play a crucial role in combating social injustice and developing the kind of critical scientific and political awareness that is essential to the redirection of the scientific and technological endeavor along more socially just and ecologically sustainable lines.

Curricular Recommendations for Makerere University A conviction of a number of university academics, professionals and university students was that Makerere University consider developing science and science education programs which foster applications of science for the common purposes of life. Science is a way of doing things - it is a method, a process that is important not only the product. This shift in science is therefore a call for changing the goals and praxis of science and technology from those of *conquering nature* to *Living in harmony with nature and others* (Brouwer, 1994; Toh & Cawagas, 1989; Fien, 1990). It means the unnatural competitiveness that has been created by modern science has to turn into cooperation. From benefits accruing to only a few, it must turn towards understanding and improving the basic living conditions (quality of life) of the majority of humanity. Towards science which makes an impact to national development, this study recommends two programs.

(A) Science, Technology, Society and Environment (STSE)
An introductory course which could be pursued at both undergraduate and graduate level, and with an open interdepartmental participation by students in the university.

I. Scientific and Technological Literacy:

To explore competing definitions of scientific and technological literacy: the different values and needs reflected, and the different knowledge, skills and attitudes promoted as well as different forms, processes and content for education.

II. Process of Scientific and Technological Innovation:

To examine the roles of the state and international forces in science and technology policy-making and practice; national and international forces in paradigms of development – and implications to science and technology agenda.

III. Sociology of Scientific and Technological Change:

IV. Interdisciplinary Cultural and Environmental Studies.

This program could take perspectives that capture the relationships between science, technology and work, education, culture, and the traditional as well as indigenous environmental knowledge. The program could highlight connections between several themes like: (i) science, technology and the traditions in Africa, focusing on Uganda (ii) science, technology and educational policy initiatives like community-based, citizenship, environmental and global education (iii) Science, technology and community living, simplicity, spirituality and ecological values.

(B) Science for Appropriate Rural Development.

The prime goal of this program would be to link basic scientific principles with rural development needs in Uganda. The program would be open to all science students at university, with strong emphasis on participation by science education students. The courses in the program would also benefit rural development workers or non-government organizations (NGO) agents in studying scientific principles underlying various rural technologies and techniques.

The themes of the program could be over-arched by "Rural Applications of Science" as a goal. Uganda being an agricultural country, such a program could inspire and instill interest and capacity among students on how human and ecological needs can be satisfied by scientific principles.

Possible dimensions of the program are:

1. Understanding aspects of science in natural processes and practices related to agriculture, forestry, livestock development, and medicine: aspects on which progress in rural areas primarily depends.
2. Science and science applications for community developers.
3. Selection, design, installation and maintenance of devices and structures for food processing and storage, housing, water supply, crop and animal husbandry and others.
4. Collaborative endeavors that can intelligently and knowledgeably contribute to local and national policy-making in areas like alternative energy development and use, land

management and allocation of scarce natural or financial resources and demographic issues.

5. Science and the environment as an aspect of social relevance of science teaching could address wider concerns related to science and society like environmental crisis, nuclear weapons, global warming, ozone depletion, waste disposal, deforestation and energy crisis, pollution, rural-urban poverty, unemployment, peace, security, industrialization, technology transfer, population issues and sustainable development. Most of these could be discussed based on local case studies.

A program on science for rural development could highlight the changing role of science education by engaging science students and science education student teachers into debating on the questions of development as industrialization as opposed to alternative visions and the role of science. Such seminal discussions could explore the moral, ethical, spiritual and or cultural implications of a development path and quality of life and environment.

The two programs fielded above could capture a wide range of curriculum and pedagogical responses in the formal and non-formal education sectors, and changes in teaching methods to emphatically espouse community-based practicums and assessment. The liberal and transformative visions displayed by most of the participants in the study suggest that these reforms are a great possibility.

A changing role of science education would be provided in the two proposed programs in their contribution to life enrichment through participation and indigenization of discourse. This process will involve the integration of facts and experiences, leading to locally meaningful emergence of ideas with school science laboratory work getting integrated in problem solving on socially lived realities.

The call for change in science by participants in this study would be accommodated in the two recommendations in science and technology education in Makerere University and other levels of education in Uganda. The lamentation that science should be relevant to understanding and resolving social problems, that facts and figures derived from science and laboratories are no longer legitimate since they represent abstract and impractical elements unrelated to living of Ugandans – call for consideration by individuals and authorities in Makerere University and government to review science and technology in the context of Ugandans and their future.

Perhaps it is time to bring closer to the students' experience, facts and practices that science and technology can be made compatible with context: cultural, historical, ecological and philosophical. Such broader perspectives of science which are not divorced from technology should allow and explicate, as Hurd (1992) has well elucidated, science and technology to evolve in parallel.

Attainment of the objectives of providing grounded valuable science that is permeated by personal and local experience in a cultural and local environment as integrative and modulating ingredients of a curriculum call for research at universities to shift to local communities in Uganda by relating it to issues and modes of thought that define meaning and welfare in the country. Such revisioned curricula which seek to place students and communities in Uganda more in control of their situation is a way for education in science and technology to be future oriented, not in the sense of predicting and controlling the future but in terms of equipping students and communities with the critical awareness, thinking and skills for shaping, coping and managing a conducive future for ecological and human survival in a sustainably balanced form.

Recommendations Beyond the Bounds of University An immediate spill-over effect of the transformations mentioned above would be a direct benefit to high schools and colleges. Science education in schools was noted by the participants as viable centers for mediating indigenous perspectives with the academic environment in schools. So the articulation of science discourse in ways that relate directly to communities' basic needs accords the youth in schools great possibilities of affirmation of science in school and indigenous science and technology by acting two-way bridges in the two systems of knowledge generation and validation. This potential is particularly crucial given that Makerere University produces a significant proportion of high school science teachers.

In a wider domain of national and the Africa region, insights gained from this study would point to a number of roles and responsibilities. First, it is vital to find appropriate organizational solutions to refocusing scientific and technological concerns of African nations to coordinate national and Africa regional efforts and resources. This could foster group strength and allow localities to transcend their areas of limitations.

Limitation of funding would appear to be a major inhibitor to fostering the evolution of appropriate science and technology in the Africa region (Achebe, et al, 1990). But this alone should not be allowed to deter initiating small-scale efforts in issue assessments and identification of theoretical and conceptual tools and methods, inducing development policies in general and science and technology policies in particular.

An expressed feeling of helplessness among science academics and other professionals in this study about poor conditions of service, lack of resources and political support could lead to total lack of enthusiasm to initiate and sustain change. Governments in the South, committed allies, particularly NGOs and donors, may need to get practical and realistic about appropriate interventions with genuine concern about national development in the framework of democracy. Such commitments might emerge more smoothly if the scientific community opened up socially in their scientific and technological activities to the wider national society through making positive impressions of the value of science and technology to the masses and their lives. When the majorities, including politicians, somehow understand the stakes involved, not only could informed choices be made but also 'popular' support for scientific and technological contribution to the nation will not stay locked in the ivory towers of institutions. As the situation currently stands, scientific and technological activity in education is marginal to the population and the politicians: it is easily ascribed as a reserve of an elite with no direct relevance to the daily needs of living.

8.3 Implications for Further Research

1. The planning and development of science and technology education needs to establish appropriate balances that reflect strategic choices in economic, social, ecological and educational policy for science and technology education. This, in Uganda, will demand the following research agenda.

It will be crucial to design an inquiry that will critically evaluate and analyze national science and technology policy in order to identify specific elements of national policy related to science and technology which have direct implications for science education; and to inquire into how these have been changing relative to developments in careers, the technology of production, and in the markets or end-use for the products. Such a study should, using a participatory action research methodology draw policy makers into dialogue with various indigenous communities on issues and perspectives of science, technology, environmental care and sustainable development. Such a research agenda would expose the elite planners, educators, and researchers to the basic assumptions of the use of modern science and technology policy in Uganda and most importantly, to the voices of the people regarding their fate under the unrelenting pressure of modernization. This could ease the process of change to future-oriented science and technology, an informed one based on increased contact between the lived realities of the masses the few who have dominated the policy-making science.

2 A second research agenda is that related to the impact of structural adjustment programs imposed by World Bank and IMF to the poor nations in the South. As Brown (1995) has clearly pointed out, many African nations are suffering due to the structural adjustment programs. Accordingly, with science and technology education at all levels demanding special facilities and materials tend to weigh heavily on budgetary provisions,

the exacting pressures of structural adjustment programs may call for a review of priorities in science and technology education. An exploration of budgetary limitations, and its implications for pursuit of alternative approaches to science and technology education could reveal options of how to make better and more efficient use of scarce resources, and of the pool of talent that exists among indigenous cultures and marginalized groups like women.

3. Because science-based education in Uganda is regarded as priority area, there is a need to establish clear understanding of the impact the existing provisions of science and technology education have had in Uganda. This inquiry could focus on investments in science and technology education, shortages of human and physical resources, and career opportunities. To the participants, a missing link which further research could highlight is the potential for establishment of science and technology units for rural communities for research, educational and extension services.

4. An equally important aspect of research in science and technology education in relation to human resource development is the differences in proportion of access of girls, rural and slum-based students, or those from poor backgrounds as opposed to boys, urban, and students from well-to-do families. Such investigations may pave ways for resources and curricula reassessment and redirection to provide a higher quality of experience based on equity. This is legitimized by noted disparities in access to science and science-based professions in Uganda (Mulemwa, 1993). As one science academic queried, the legitimacy of having science specialization by students to begin as early as senior five of the secondary level of education may also need to be closely interrogated. Equity and a holistic concept of efficiency based on local cultural consistency could weigh in favor of considering whether the dominant patterns of access and curriculum option patterns at other levels of education in Uganda are rational and just.

Scholars like Keller (1992) implore egalitarianism in the representation of science and technology as a means of encouraging equal motivation and participation of boys and girls. Some participants similarly argued that in order to adequately deal with the problems and promises generated by advanced industries, women and young girls should be encouraged to make their contribution. Makerere University's Affirmative Action program of giving female applicants 1.5 extra points on top their national examination scores as a means to improve their chances of admission to science and other professional programs was seen as insufficient. Some participants felt that this already favored an educated and privileged group of women. A research agenda in this respect would lie in assessing views, ways and policy implications for comprehensive efforts to expand similar incentives for girls in education at all levels, including adult education for rural women. This research effort could become an integral theme for seeking answers to questions like: What difference does the adoption of a feminist perspective make in relation to traditional knowledge in the African (Ugandan) context? How are feminist perspectives affected by differences of culture, education, age, and urban-rural location, between women? What implications do these have in science and technology education for women? These kinds of questions require a re-evaluation of issues of objectivity and justification of knowledge claims and allows voices of indigenous women and educators to express their lived experiences. These may provide some insights into the issues regarding traditional epistemology, an area gaining attention in educational research.

5. The initiative of this my study needs to be pursued through a comprehensive and critical synthesis of various dimensions of indigenous knowledge in Uganda including the conceptual and skill facets of indigenous science and technology and respective artifacts. The main objectives here would also be to evolve a research methodology of interacting with indigenous cultures and catalogue this information for further synthesis between regions and cultures. This data would be brought to bear on both policies; and is an indispensable take-off point in the framing of ecoscience for sustainable development.

Some Personal Reflections

Challenges will come and should be anticipated, often involving an overhaul of the familiar or constitutive rules. I find some reflections of the moving story in the Bible about David and Goliath the Giant appropriate at this point. In this Bible story, Goliath is a huge, ferocious and adroit fighter whose stature alone stymied all opposing armies. His fighting regalia, tactics and weapons sent a chill down anyone's spine. When little young David's people were faced by the threat of invasion by Goliath, the odds against David were staggeringly obvious. And David knew this. But he also knew that he had to fight or perish with the little left of his people and possessions. What David did is probably instructive to what Ugandans should engage in today. David confronted his limitations, and his great odds against Goliath. With what I might call a Gestalt flash and shift, an "*aha!*," David must have realized that the odds would be heavily against him if he took to challenging Goliath under the conventional fighting tactics: a sword fight. In the *aha!* flash, David may have realized that if he changed the rules of the game, his vulnerability would shift, the odds would reduce and the inevitable fight would occur under the conditions of fairness, equity, and justice.

What choices did David make? He fell back to what he was most familiar from childhood; something he had grown with, played with, and had defined his livelihood with: a sling. With his sling he did not have to come to Goliath's arm and or sword's reach. On the day of confrontation, the small army he belonged to stood far behind him, probably falling apart with fright over David's and eventually their plight. But David's best considered scheme worked, and resoundingly so. Goliath was felled by a single shot form the sling followed by celebration for a victory founded on critical reflection and understanding of the 'landscape.' Similarly Ugandans can and should make choices. A point to begin is like that of David: confronting local limitations and shortcomings against the looming sociocultural, economic and environmental problems faced. Ugandans also need to reflect on what they have and where they could begin in ways that are divergent from what the problem and dominant thinking has continually told us we cannot do. Such reflections in the social, cultural/spiritual, educational, and ecological domains are all important dimensions and cues of the internal dialogue process we need to engage in with a sense of authenticity and commitment, giving weight and priority to direct experience, reciprocal communication.

Any proposed development project needs to be examined by dialogue about whether it promotes justice, restores reciprocity, and or confers divisible or indivisible benefits. Such dialogue would also expose whether the proposed project favors science and technology over people; whether conservation of ecological systems' integrity and recovery is favored over waste; and whether its strategy maximizes gain or minimizes disaster and whether the reversible is favored over the irreversible. What Ugandans can take away from the David-Goliath fable above is also a need to develop a *redemptive* discourse in science and technology, recognizing, as some participants commend, existing indigenous forms as potentially viable starting points of departure and or focus. This way Ugandans could begin to seek reclamation of knowing and doing things in ways that facilitate cooperation without centralization, intimidation, coercion or oppression by scale. This thinking and acting in redemptive discourse in science and technology could inhibit proliferation of harmful scientific and technological experiments and/or applications. It could also inspire redesigning of industrial processes leading to reductions in pollution, elimination or reduction of waste, and as Lovins (1989) calls it, modification of needs and demands. The concept of pollution and waste reduction should extend to conceptual, value, attitudinal, and cultural domains. Redemptive discourse in science could therefore shape and promote and diversify anticipatory strategies in all phases as opposed to reactive strategies, which in Uganda, have tended to be characterized by impromptu, often driven crisis. The water hyacinth on Lake Victoria which started on small manageable scales five years ago has now choked water ways including the single main hydro-power plant at the source of the river Nile. Now consideration is on whether to use chemical means for eliminating the weed at the risk of poisoning the fresh waters, curtailing the fishing industry and damaging other aquatic life on the lake. The water hyacinth on Lake Victoria is an immense challenge to Uganda and the neighbors and calls for the critical scientific and technological analysis in finding out how to deal with such ecological disasters. Good ways of knowing and doing require critical studies of activities and arrangements that work well and appropriate to the needs of the people (Freire, 1995). This will require that these activities be context-specific and micro in design (McRobie, 1981). A gateway to this framework lies in committed exploratory and participatory inquiries as a continuous process of disaster minimization.

A second characteristic of redemptive discourse is the direct involvement of those at its receiving end. This is particularly crucial for science and technology in their use to address continuously changing needs. A redemptive discourse in this respect would infuse considerations such as personal and communal monitoring of ecological-related parameters in the ecosystems, health parameters, nutrition, agriculture, cultural discourse, easy ways to access relevant information and the protection of individual as well as community rights and well-being. This element of redemptive discourse would constitute an evolution of a science and technology constructed on the basics of "bottom-up" or grass-roots model. It would constitute a science and technology for liberation, an approach to new knowledge which Ivan Illich (1980) in his essay "Research by People" – gives a sense of ownership and identity. A grassroots based science and technology will infuse avenues for reciprocity and include culturally coded indicators of the onset of problems in the physical, cultural, ecological, health or other wider social concerns. This strategy will require a discursive approach of pursuing and maintaining "checks and balances" and a sense of accountability that juxtaposes physical gains and losses of any activity against individual, social, cultural, and ecological impacts. This cataloguing of gains and losses requires faithful and democratic reflections of all interested parties. Thirdly there must be an honest ecological accounting detailing gains and losses in the health and viability of the ecological systems and the constructed environments. The fourth element of redemptive discourse in science and technology is its role in helping to shape our society towards reclamation of an indigenous contract of science and technology which seeks to overcome the dominant disenfranchisement of the majorities of peoples in Uganda. Such a social contract would derive its inspiration from the demonstrated stewardship for people, culture, and nature by those who govern, seek to develop, and educate Uganda.

The How? Question There has been much of enthusiasm on my part in seeking participants' views on the issues raised in this study. Throughout this process, my hopes were to identify not only the respondents' thoughts about the role of science and technology in social and environmental problems, but to come across insights onto how such a science could come about, how it will be identified, and implemented for the benefit of the majorities.

In this study's inquiries onto how science discourse could be revisioned for appropriate technological interventions to development informed by indigenous knowledge for socially and ecologically just ways of living, the responses by participants invited another dimension to the problem. They clearly saw the need to transform educational institutions, to empower learners and educators and to establish close linkages and partnerships with communities. They agreed on the need to catalyze dialogue between scientists, professionals, politicians and the grass roots' realities regarding social and ecological problems with a view to establishing democratic identification of problems and feasible solutions to them. In all these animated discussions, and throughout the last few months of poring through the transcripts and writing this account, I have increasingly been confronted with the question: "How do I do this?" It is increasingly apparent that the question could be a defense against initiating action. To attach a lot of importance to *How?* could be to leap past the question of purpose, past the question of intentions, and past the centrality of personal responsibility and commitment. Over and above all these, while acknowledging the value of partnership as solidarity, the question of *How?* tends to focus on seeking for solutions from out there, hence breeding dependence. It is also an indirect expression of doubts, which prefers ready-made manuals and recipes. To launch oneself in an outward search for answers could be to express ones doubts about being, having and doing enough. The surface currents that underlie the question of *how* relate to getting to the practical: *tell me where it is working*; *show me how to do it*; *prove it to me!* : the domain of a high level of skepticism. The answer to *How?* would benefit from a rephrasing of the questions that underlie this inquiry on the scale of an individual: Is it feasible for a Ugandan to revision, claim, and live his or her freedom amidst the ecological crisis today based on indigenous science and technology? Is it feasible for formal science to make a contribution to this form of culturally directed development? Is it feasible for a Ugandan to feel safe and secure within the provisions of nature while pursuing personal freedom and search for ways into a sustainable future? These are questions for institutions as well as for individuals. These are the kind of issues that communities, work or profession, and organizations exist to answer. The problem could be that the institutions we have inherited from colonialism no longer seem to deliver nor honor choice, service or security for the majorities they purport to serve. There is something in the nature of institutions that seems to deflect them away from the service and freedom that they were created for. Even as a nation, it would appear that the founding instincts of life and liberty have been distorted into materialism and economic interests, a form of reductionism Arne Naess (1989) has called a pursuit of a "standard of living" in place of "quality living".

The intensity of the question of *How?* is an expression of our having surrendered some part of ourselves, our own struggle with purpose and destiny, by constantly kneeling at the altar of experience. Perhaps it is time to take responsibility for personal freedom with commitment to service and having faith that the best security and the location of the solutions to the *How?* question lies in oneself. In this framework, institutions and other embodiments of community become the alchemy for discovering the answer. To resist this personal approach to crisis outlined in this study is to identify with the dominant illusion that an answer to ecological and social problems defined by modernization in Uganda can be found only in the classroom and laboratories.

Personally, my institution and location in Makerere University is important because it becomes a means of overcoming my isolation from colleagues of similar vision in finding answers and strategies to these questions. Viewed in the light of this challenge, an institution like Makerere translates into a venue of interdependence, where cohabitants are participants who need each other for many reasons, emotionally and practically. The answer to *How?* then, is to be first and foremost located inside oneself. To look for and follow action plans and prescriptions laid down by others is non-liberating. It is the scientist in us that tends to look outside ourselves - into Popper's World 3 - wanting to know ahead of time what steps to take: a desire for a safe and predicable future. What Ugandans need is a safe and sustainable future based on local resources and environmental heritage.

8.4 Conclusion

Any reflection on science which tends to overlook the political economy of knowledge, or the ethics of science could be doomed to bypass the most essential contradictions involved in contemporary scientific practice. It has been argued by participants in this study that the access of Ugandans to science, and its technological ramifications, including the possibility of Ugandans participating efficiently and usefully in contemporary scientific activity, is limited by policies of the state and by an unequal international division of labor that confine South societies to the role of mere consumers of scientific products from elsewhere, including knowledge. In the ethical dimension, science discourse in its epistemological standpoint, has seen Ugandan schooling seeking to endow students with as much truthful knowledge as possible. This focus of science in education was therefore seen as leading to applications which sometimes raises the dramatic problem of the value of science, of life, of ecosystems or even of life and ecosystems as valuables.

The fundamental outcome of this study is that although the nations in sub-Sahara Africa like Uganda have scientific practice which, relative to industrialized world, is at an embryonic stage. There should be no complacency over the ethical and moral considerations of science and technology. To surrender these considerations to the hands of the highly educated in the industrialized nations could be to succumb to domination, control and loss of self-directedness into the future. It was the considered opinion of the study participants that denying science a human and an ecological perspective would allow scientific and technological complex control people's lives. The contemporary picture of scientifically and technologically driven industrial, agricultural and commercial growth globally have, in their wake spawned ecological, social, political, and economic crisis that impact heavily on the poor nations (Wiltshire, 1993). The resultant changes of modernization espoused by scientific and technological advancement are particularly felt in some rural locations, exemplified in this study by the Osukuru community The Osukuru elders have expressed how industrialization in their neighborhood has deeply affected their existence, brought in elements of a new social order, and shaken their traditional certainties and identities into confusion. While these elders were pessimistic that nothing could be done, the frightening times could also trigger and stimulate intellectual thought among the academics and educators in particular.

The realities communicated in this study indeed invite specialists from various scientific disciplines to devise innovative approaches to face the ongoing changes, redefine concepts and be relevant to the lives of average Ugandans. The challenge is for Ugandan scientists to appropriately define science and technology that could help reverse the problems of development approaches that must be collaborative and mutually empowering. It also demands an identification of responses likely to meet these identified needs and aspirations, as well a framework and strategies for implementation. Such a process also accords occasions to re-examine the role of science in the frameworks involved, and in the context of cultural realities and historical contingencies specific to Uganda and the sub-Sahara region. A caution is well sound by Pepper (1986) who has argued well that revisiting the 'development' concept - whether on the basis of the dismal failure of the authoritarian model in the former bureaucratic communist countries or through the less conspicuous but nonetheless real failures of the industrialized capitalist nations – needs cognizance of the fact that despite their major differences, capitalism and communism operated on the same assumption. Freedom and happiness of societies depend on their capacity to domesticate science, which, according to the well documented dictum of Descartes, could make people the master and owners of nature (Scheman, 1996; Simmons, 1993). Such a logic of appropriation of the real by the spirit, and of the domination of nature by human scientific and technological activity is essentially quantitative and materialistic. Scientific methods have been applied towards a dangerous and irrational management of ecological heritage and the pursuit of profit maximization. The gap between the rich and the poor is commonly observed as increasing, between the North and South, and within each of these settings. While science and technology has accounted for the increase in this wealth and poverty gap, they have not yet come up with ways to reduce the gap. In summary, the use of science and its technological ramifications in the best interests of traditional majorities and indeed for all citizens in nations like Uganda, should become central points for reflection and departure into the future of science. These concerns could open up pathways to a carefully monitored scientific development, while paying careful attention to the ecological warnings against the potential risks involved in which the industrialized countries have so far used science and technology.

Science and technology will stay central in any form of development because of their capacity to harness both the social and natural environments. In the African context, what is echoed by participants is the need to avoid reducing 'development' to science and technology. What might be a useful place to begin reconceptualizing science in a development endogenous to traditional Africans is a fostering and inculcation of a culture of holistic development among the thinking of the rural and urban majorities. This argument does not however, deny the role of scientific values like critical thinking, skepticism to what is upheld as 'truth', capacity to innovate and assimilate, and collaboration in promoting critical and holistic development.

The strongest implication of the concept of domestication of science and development is the opportunity nations in the South like Uganda have to interrogate indigenous knowledge and know-how, the reason being that traditional knowledge and know-how (technology) which has contributed to societal well-being over the ages. As Ilukor (1992) equally asserts, relevant integration where appropriate, of modern and indigenous science and technology can help to maximize the use of local resources and reduce the costs of excessive dependence on foreign technologies.

The above considerations hold strategic implications in the areas of education, teacher education, and research. Higher priority will need to be given in the design and implementation of development policies, and the incentives and obligations accorded to staff in these sectors. The other implication is the need to open up our learning, training and research institutions in all aspects to our endogenous and indigenous practices and knowledge. Thus called for is the need to break away from the pseudo-modernist conservatism which has tended to disown and isolate endogenous and indigenous know-how and knowledge system. A systematic inventory - free from positivist bias - of this vast field of knowledge, experiences and practices accumulated over centuries among traditional communities in rural Africa will help to revision the field of science and technology. South nations like Uganda will be get better placed in the journey to a sustainable future. An independent, integrated and self-sustaining economy will draw on African perspectives in understanding science and in developing technologies relevant to both the natural and cultural environment.

The scientific era of the twenty-first century will require various approaches for, and perspectives of scientific literacy in different cultural settings. Our claims to democracy require that decisions about development not be taken unless the underlying scientific and technological issues are properly understood and this understanding built into the decision-making process for the benefit of the majorities and the ecosystems. What the poor nations in the South need in this era of globalization is a clear understanding of the social and ecological responsibility of science and its technological applications. Through this study, the voices of a range of Ugandans including indigenous elders have contributed meaningful insights and perspectives of how science should and can help sustain social and ecological responsibility.

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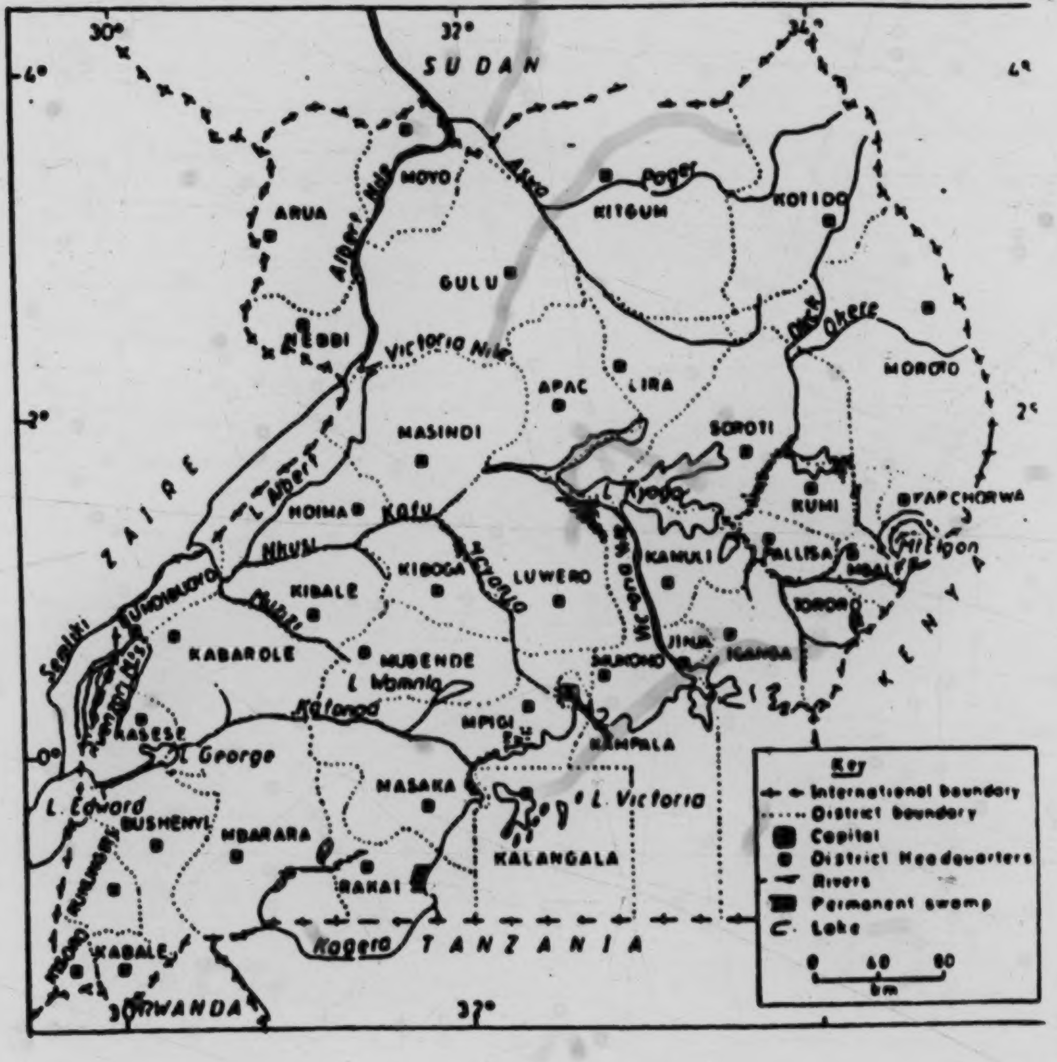
APPENDIX A1

Map of Africa showing the Location of Uganda

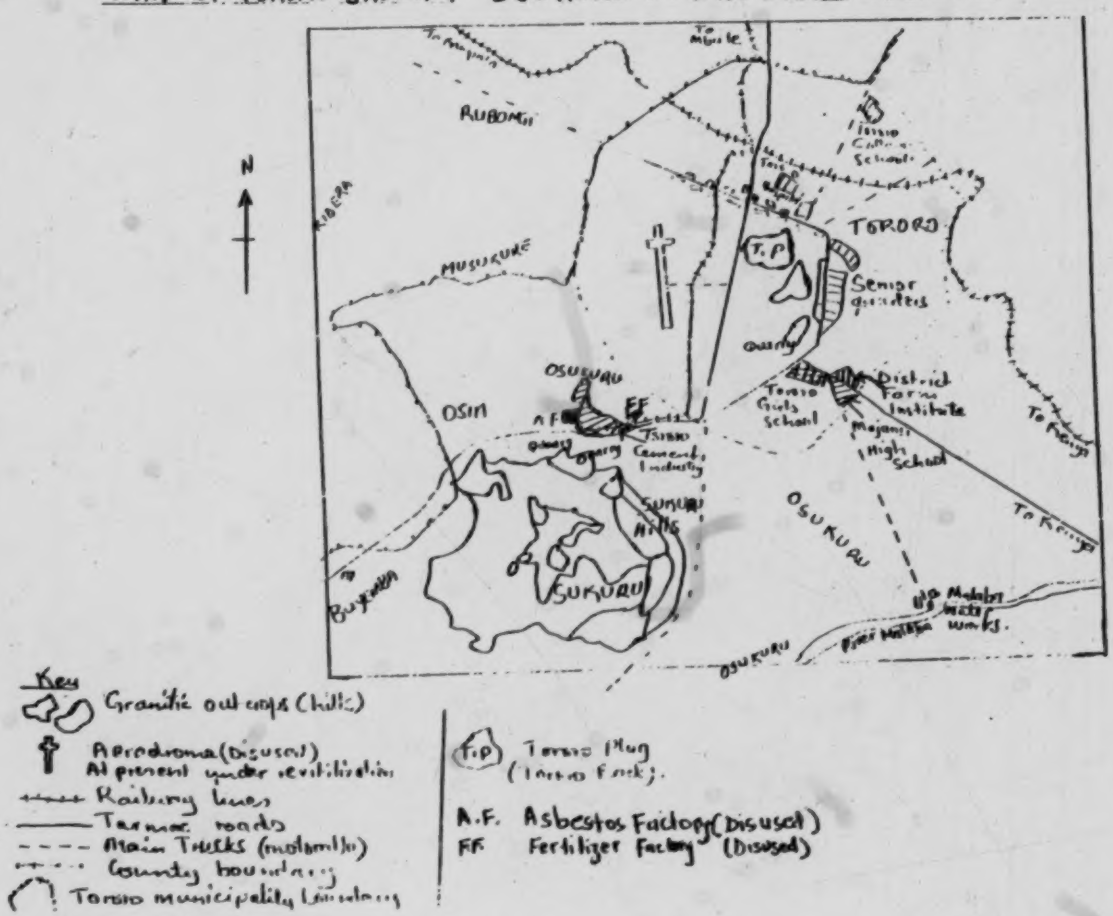
N
Africa
Uganda
Equator
0°
400 0 400 800 1200
Kilometres

APPENDIX A2 Uganda: Physical and political

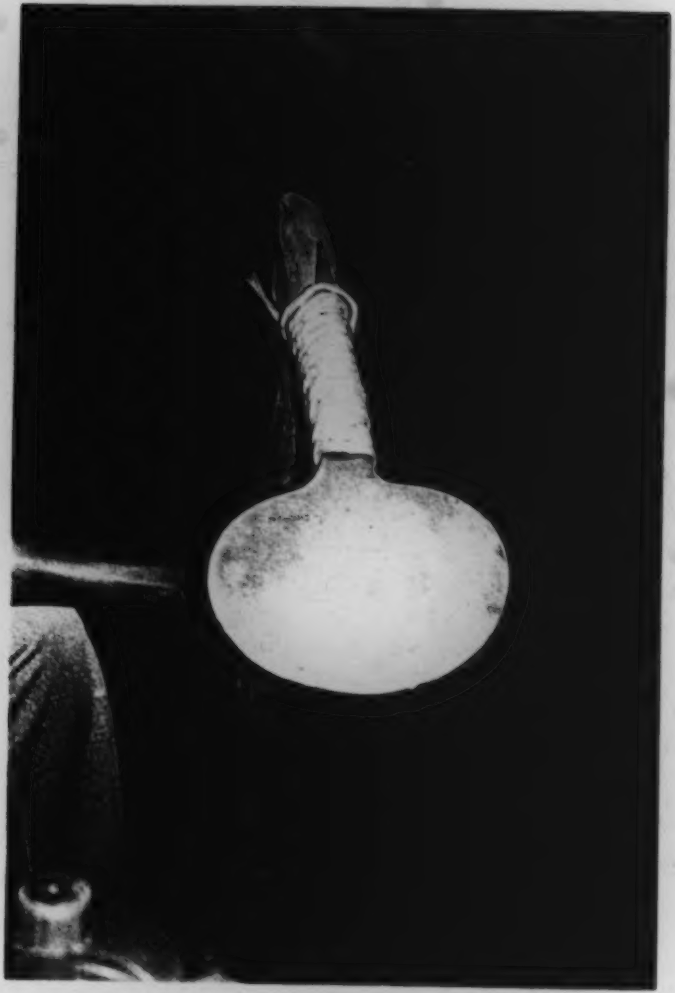

30°
32°
34°
4°
2°
0°
SUDAN
ZAIRE
KENYA
TANZANIA
RWANDA
MOYO
ARUA
Albert Nile
Aswa
Pager
KITGUM
KOTIDO
GULU
NEBBI
Victoria Nile
Dopeth
Okere
MOROTO
APAC
LIRA
MASINDI
SOROTI
L. Albert
L. Kyoga
KUMI
KAPCHORWA
HOIMA
Kafu
Nkusi
Mt. Elgon
PALLISA
MBALE
KIBOGA
LUWERO
KAMULI
Victoria Nile
TORORO
KIBALE
Muzizi
Semliki
KABAROLE
MUBENDE
JINJA
IGANGA
MUKONO
Ruwenzori Mts
L. Wamala
MPIGI
Katonga
KASESE
KAMPALA
L. George
MASAKA
L. Victoria
L. Edward
BUSHENYI
MBARARA
KALANGALA
RAKAI
Kagera
KABALE
RUKUNGIRI
KISORO
32°
Key
International boundary
District boundary
Capital
District Headquarters
Rivers
Permanent swamp
Lake
0
40
80
km

APPENDIX A3

MAP OF TORORO SHOWING OSUKURU LOCATION AND NEIGHBOURING AREAS


N
To Mbale
To Nagongera
RUBONGI
Tororo College School
Tororo
TORORO
KIDERA
MUSUKURE
T.P
Senior quarters
Quarry
District Farm Institute
Tororo Girls School
Mojanji High School
To Kenya
To Kenya
OSUKURU
OSIM
A.F
FF
Tororo Cement Industry
Quarry
Quarry
SUKURU HILLS
SUKURU
Buyaka
OSUKURU
OSUKURU
River Malaba
Malaba water works.
Key
Granitic outcrops (hills)
Aerodrome (Disused) At present under revitilisation
Railway lines
Tarmac roads
Main Tracks (motorable)
County boundary
Tororo municipality boundary
T.P Tororo Plug (Tororo Rock).
A.F. Asbestos Factory (Disused)
FF Fertilizer Factory (Disused)

APPENDIX B1



An indigenous technology: A hoe made within the Osukuru community in the early 1900s, now being kept for symbolic purposes. There are few such traditional tools being made now due to increasing technology transfer.

APPENDIX B2

In the surrounding areas of the Osukuru hills, there are many cottage industries making lime using open-top brick ovens (Top picture). These are mainly run and owned by business men who have managed to mimic the Cement Industry Technology. Although a simple technology, these have high woodfuel demand (Lower Picture), causing further deforestation in the area. It is also an unhealthy vocation for the poor workers who are exposed to hazardous gaseous fumes and lime dust. This practice is not regulated.

APPENDIX B3

The Tororo Cement Factory (top picture); and the view of Osukuru hills and village from Tororo Girls High School which is located to the East of the hills. The picture shows a high degree of devegatation both on what the elders informed was previously a forested area, right to the hill sides.

APPENDIX B4

The only main source of water to the Osukuru community: with evidence of siltation due to soil erosion, and potential contamination from fecal matter, and other forms of waste in the devegated environment.

APPENDIX C

Summary of Courses at Faculty of Science, and Department of Science and Technical Education Makerere University

Biological Sciences (Biochemistry/Botany/Zoology)

Year I

Biological basis of human ecology; Cellular Biology; Developmental Biology; History and Theory of Biology; Plant Biology and the Plant Kingdom; Insect Biology; Heredity; Genetics and Human Welfare; Principles of Animal

Year II

Cell Physiology; Plant Structure and Development; Plant Ecology and Systematics; Plant Physiology; Marine Biology; Entomology; Foundations of Molecular Genetics/Population Genetics; Biology of Fungi; Plant Systematics.

Year III

Ethno-onthology and ethnobotany; Physiology of Growth; Paleobotany; Molecular Plant Development; Biostatistics; Natural Products; Molecular Spectroscopy and Structure; Plant Biotechnology; Insect Function and Development; Marine Ecology Labs; Plant Taxonomy Research Project.

Department of Science and Technology Education (DOSATE)

(Agriculture, Biology, Chemistry, Mathematics, Physical Education, and Physics Units)

The Agriculture, Chemistry, Mathematics and Physics units have their respective students being taught the "content" at the faculty of Science, with DOSATE simply teaching the science education aspects. The Agriculture unit takes students who have already acquired a BSc (Agric) degree on a nine-month Postgraduate Diploma in Education.

The science education programs in Chemistry, Agriculture, Mathematics independently cover: objectives of (subject) education, brief history of subject, its nature. Elements of the subject syllabus in schools, and its interpretation into teaching units, are expounded. The role of practicals, teaching methods for the subject, classroom management, assessment of students, are discussed and practiced through micro-teaching clinics. The overall assessment of teaching involves two Practicum sessions for undergraduates and one for postgraduate students.

The Biology and Physical Education Units each teaches both the "content" and the science education components of the programs.

Department of Chemistry

Year I

Introduction to University Chemistry; Organic Chemistry; Quantitative Analysis; Inorganic Chemistry; Labs.

Year II

Physical Chemistry; Instrumentation in Chemical Analysis; Inorganic Chemistry; Organic Chemistry; Labs.

Year III

Organic Chemistry; Industrial Chemistry; Atoms, Molecules and Electromagnetic Radiation; Advanced Physical Chemistry; Analytical Spectroscopy; Kinetetics, Surfaces and Catalysis; Analytical Electrochemistry; X-ray Crystallography; Inorganic Reaction Mechanisms; Organic Synthesis; Analytical Chemistry; Magnetic Resonance in Chemistry; Labs.

Department of Geology

Year I

Geologic and Biological processes; Physical Geology; Geology Field School; Earth Science I; Labs.

Year II & III

Earth Science II, Environment Earth; Principles of Paleontology; Principles of Sedimentation and Stratigraphy; Mineralogy; Geologic Mapping; Earth's Physical Resources; Paleontology; Stratigraphy; Geochemistry; Petrology; Geotechnics; Structural Geology; Seismic Exploration Methods; Labs.

Department of Physics

Year I

Mathematical Physics; Modern Physics; Heat and Thermodynamics; Introductory Electromagnetism; Physics of Materials; Wave Mechanics; Labs.

Year II

Classical Mechanics; Quantum Mechanics; Electrodynamics; Statistical Physics; Solid State Physics; Relativistic Modern Physics; Mathematical Physics; Electronics; Labs.

Year III

Geophysics; Classical Mechanics; Quantum Mechanics; Electrodynamics; Statistical Physics; Solid State Physics; Mathematical Physics; Tensor Analysis; Electronics; Labs.

Ongoing Projects

Biogas Energy Systems – (Professor Ilukor); Solar Energy in Harvest Loss Minimization: (Professor Ilukor); Photovoltaic Cell Project (Ociti and Esiaugu); Clay Project (Associate Professor Banda); Radiation Protection (Professor Ilukor, Kisolo and Odongo-Edimu); Earthquake Disaster Inventory and Early Warning System (Twesigomwe).

Institute of Environment and Natural Resources Conservation

(Graduate Program Only)

Wildlife Biodiversity; Plant Resources; Wildlife-Habitat Conservation and Management, Resources; Pollution and Pollution control; Soil, Water and Energy Conservation; Environmental Impact Assessment; The Geographical Information System (GIS)/Remote Sensing Techniques.

Makerere University Faculty Science, and DOSATE offices

APPENDIX D1

Centre for International Education and Development
University of Alberta Department of Educational Policy Studies
Edmonton Faculty of Education

Canada T6G 2G5 7-104 Education Building North,
Telephone (403) 492-7229
Fax (403) 492-0762

June 17, 1995

Director
Uganda National Research Council
Kampala, Uganda

Dear Sir/Madam:

On behalf of the Centre for International Education & Development, I am writing in support of the application of Mr. Silas Oluka, Lecturer, School of Education, University of Makerere, to conduct educational research in you College. Mr. Oluka is a participant of the CIDA -CIED institutional linkage project between the University of Alberta and Makerere University. He is presently enrolled in the Ph.D. program in Secondary Education, University of Alberta. I and Dr. Wytze Brower, professor of Secondary Education & Physics, are serving as his thesis supervisors. Mr. Oluka is especially interested in the response of Makerere University scientist and science educators to the role of indigenous knowldege in sustainable development and environment.

During his fieldwork in Uganda over the period August - December, 1995, Mr. Oluka will be studying the views of scientist and science educators at Makerere University as well as those of Uganda citizens in rural community in Tororo District. His research will involve collecting documentary material, interviewing Makerere lecturers and students, teachers, policy-makers, administrators, and indigenous citizens on issues related to environment and development and the role of indigenous or traditional knowledge. I am confident that Mr. Oluka's proposed research wll yield useful and important recommendations for improving science and science education programs in Makerere University and other educational institutions in Uganda.

I would be grateful if you would kindly approve and facilitate Mr. Oluka's application to conduct the above described research study in Uganda.

Yours sincerely

Dr. S.H.Toh
Director, CIED
and Co-Director, Uganda Project

c.c. Dr. W. Samiroden , Co-Director, Uganda Project
Dr. M.Odada, Acting director, Uganda Project
Dr. C. F. Odaet, Director, Uganda Project (on leave)

APPENDIX D2

Centre for International Education and Development
Department of Educational Policy Studies
Faculty of Education

University of Alberta
Edmonton

Canada T6G 2G5

7-104 Education Building North,
Telephone (403) 492-7229
Fax (403) 492-0762

June 17, 1995

The Dean, Faculty of Science
Professor Luboobi
Makerere University
Kampala, Uganda

Dear Professor Luboobi:

On behalf of the Centre for International Education & Development, I am writing in support of the application of Mr. Silas Oluka, Lecturer, School of Education, University of Makerere, to conduct educational research in you College. Mr. Oluka is a participant of the CIDA -CIED institutional linkage project between the University of Alberta and Makerere University. He is presently enrolled in the Ph.D. program in Secondary Education, University of Alberta. I and Dr. Wytze Brower, professor of Secondary Education & Physics, are serving as his thesis supervisors. Mr. Oluka is especially interested in the response of Makerere University scientist and science educators to the role of indigenous knowldege in sustainable development and environment.

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I would be grateful if you would kindly approve and facilitate Mr. Oluka's proposed study in your faculty.

Yours sincerely

Dr. S.H.Toh
Director, CIED
and Co-Director, Uganda Project

c.c. Heads of Departments, Makerere University
Dr. W. Samiroden , Co-Director, Uganda Project
Dr. M.Odada, Acting director, Uganda Project
Dr. C. F. Odaet, Director, Uganda Project (on leave)

APPENDIX D3

University of Alberta
Edmonton

Centre for International Education and Development
Department of Educational Policy Studies
Faculty of Education

Canada T6G 2G5

7-104 Education Building North,
Telephone (403) 492-7229
Fax (403) 492-0762

June 17, 1995

The Dean, Faculty of Education
Professor John C. Ssekamwa
Makerere University
Kampala, Uganda

Dear Professor Ssekamwa:

On behalf of the Centre for International Education & Development, I am writing in support of the application of Mr. Silas Oluka, Lecturer, School of Education, University of Makerere, to conduct educational research in you College. Mr. Oluka is a participant of the CIDA -CIED institutional linkage project between the University of Alberta and Makerere University. He is presently enrolled in the Ph.D. program in Secondary Education, University of Alberta. I and Dr. Wytze Brower, professor of Secondary Education & Physics, are serving as his thesis supervisors. Mr. Oluka is especially interested in the response of Makerere University scientist and science educators to the role of indigenous knowldege in sustainable development and environment.

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I would be grateful if you would kindly approve and facilitate Mr. Oluka's proposed study in your faculty.

Yours sincerely

Dr. S.H.Toh
Director, CIED
and Co-Director, Uganda Project

c.c. Heads of Departments, Makerere University
Dr. W. Samiroden , Co-Director, Uganda Project
Dr. M.Odada, Acting director, Uganda Project
Dr. C. F. Odaet, Director, Uganda Project (on leave)

APPENDIX D4

University of Alberta
Edmonton

Centre for International Education and Development
Department of Educational Policy Studies
Faculty of Education

Canada T6G 2G5

7-104 Education Building North,
Telephone (403) 492-7229
Fax (403) 492-0762

June 17, 1995

The Central Government Representative - Toroto District
Uganda

Dear Sir/Madam:

On behalf of the Centre for International Education & Development, I am writing in support of the application of Mr. Silas Oluka, Lecturer, School of Education, University of Makerere, to conduct educational research in you College. Mr. Oluka is a participant of the CIDA -CIED institutional linkage project between the University of Alberta and Makerere University. He is presently enrolled in the Ph.D. program in Secondary Education, University of Alberta. I and Dr. Wytze Brower, professor of Secondary Education & Physics, are serving as his thesis supervisors. Mr. Oluka is especially interested in the response of Makerere University scientist and science educators to the role of indigenous knowldege in sustainable development and environment.

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I would be grateful if you would kindly approve and facilitate Mr. Oluka's proposed study in the Tororo District. Your assistance in guiding him to local citizens who are very knowledgable in indigenous or traditional beliefs and practices will be greatly appreciated.

Yours sincerely

Dr. S.H.Toh
Director, CIED
and Co-Director, Uganda Project

c.c. RC IV Chairperson - Osukuru Subcounty
RC III Chairperson - Osukuru Parish
RC II Chairperson - Osukuru Parish
RC I Chairperson - Osukuru Parish
RC Women's Representative Toroto District
Heads of Departments, Makerere University
Dr. W. Samiroden , Co-Director, Uganda Project
Dr. M.Odada, Acting director, Uganda Project
Dr. C. F. Odaet, Director, Uganda Project (on leave)

APPENDIX D5

UGANDA NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

PHONES: 250499 (General)
CUTIVE SECRETARY'S DIRECT LINE: 250431
X NO. .... TELEFAX NO. 234579

76 BUGANDA ROAD
P.O. BOX 6884,
KAMPALA, UGANDA

Ref SS 927

Date 2nd October 1995

Ref:

District Executive Secretary
Tororo District
P. O. box 1
TORORO

Dear Sir/Madam,

RE : RESEARCH APPROVAL

This is to introduce Oluka Silas who wishes to undertake a research study entitled Environmental and socio-cultural perspective in postmodern science - insights from Uganda and implications for higher education in your district.

The study has been approves by the Uganda National Council for Science and Technology. It awaits clearance from the President's Office, this being in the final stages.

The purpose of this letter is to request you to allow the researcher to conduct the preliminary study which will facilitate the main study research methodology.

Your cooperation in this matter is much appreciated.

Yours sincerely,

P. Kabasa
for : Executive Secretary
UGANDA NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY